Canadian Journal of
PUBLIC HEALTH

VOLUME 34
NUMBER 3

TORONTO
MARCH, 1943

Bacterial Food Poisoning*

PART I†

C. E. DOLMAN, M.B., B.S., M.R.C.P., D.P.H., PH.D. (LOND.)
Research Member, Connaught Laboratories (Western Division)
University of Toronto;
Director, Division of Laboratories
Provincial Board of Health of British Columbia;
AND
Professor of Bacteriology and Preventive Medicine,
The University of British Columbia, Vancouver

THE war has brought about a notable upsurge of anxiety over the whole question of food supplies, which is shared by both laity and professional public health workers. The layman's disquiet is due in part to an increasing awareness of the extent of malnutrition, and in part to the actual or impending shortages of certain foodstuffs, whose protection from spoilage he now realizes has become more than ever an individual and national obligation. The professional worker, on the other hand, is more concerned about the inevitable effects of deteriorating standards of simple sanitation upon water, milk and food supplies; and about the best means not merely of applying to fullest advantage the latest findings of nutritionists, but also of ensuring the maximum possible freedom of comestibles from contamination. Bacteriologists in particular are impressed by the fact that to arrange for large, tasty, nutritious meals, and yet do little to prevent pollution of the food with e.g. dysentery bacilli or staphylococci, involves the possibility of a situation arising in which

**Based on addresses given before the Pasteur Society of Central California, at Berkeley, November 5, 1942, and presented at the eleventh annual Christmas meeting of the Laboratory Section, Canadian Public Health Association, held in Toronto, December 17 and 18, 1942.*

†A second section of this paper, which will include a discussion of staphylococcus food poisoning, with new experimental data relating thereto, will be published in the April issue of the JOURNAL.

the bigger the meal, the more bitter the misery. As war-time conditions increasingly afflict this continent, the problem of bacterial food poisoning is likely to assume greater importance. An attempt will therefore be made in this paper to outline the problem, and to bring it into focus in the light of current knowledge concerning its aetiology.

FOOD-BORNE INFECTION DUE TO LOW STANDARDS OF SANITATION

Certain lapses of community sanitation which involve food-borne infection hazards may fittingly be mentioned first. Our margin of security against such hazards is normally maintained by constant and conscientious laboratory control, by regular supervision and inspection, by continually strengthening and firmly enforcing public health regulations, and by patient efforts to train intermediaries to bridge the gulf between what is known and preached by the few, and what is apprehended and practised by the many. In times like these, this margin of security is in jeopardy, owing to the loss of trained public health personnel of all categories to the Armed Forces and to war industries; to the failure of meagre appropriations for public health to keep pace with the greater burdens imposed on them; to the inevitable tendency towards diversion of public funds and interest from the pursuit of our own health and welfare to the assurance of our enemies' ultimate lack of it; to increasing demands upon the resources of public health laboratories, which have compelled them in some instances to turn to unsatisfactory improvisations of procedure and technique; and finally to an imponderable threat of possible disruption of sanitation through enemy action, whether by sabotage or bombardment.

Water Supplies

The foregoing comments largely account for the fact that although the general principles underlying the provision of safe supplies of water, milk and milk products, meat, fish and shellfish, have long been established, they often remain perfunctorily applied. For instance, despite the high percentage of municipal water supplies in North America conforming to the stringent bacteriological standards which competent authorities believe should be imposed, the odd city is still to be found taking vehement exception to the introduction of chlorination as a safeguard; while in the smaller rural settlements, and in unorganized territories, water supplies are more often than not potentially unsafe. Apparently leptospirosis, brucellosis, tularaemia and poliomyelitis should be added to cholera, typhoid and paratyphoid fevers, and the dysenteries on the list of infections which may be water-borne. It seems strange that all these hazards should be so unconcernedly accepted by certain communities in a land where water is served to drink at almost every meal, where uncooked salads are apt to accompany even hot dishes, and where raw sea foods are by some much esteemed.

Milk Supplies

Still more extraordinary is the strength of the opposition to the rendering of milk and milk products safe for human consumption by pasteurization.

To the well-known list of infections which may be milk-borne—cholera, typhoid and paratyphoid fevers, the dysenteries, tuberculosis, scarlet fever, septic sore throat and diphtheria—must be added certain Salmonella infections, brucellosis, staphylococcal food poisoning and poliomyelitis. There is no record of properly-pasteurized milk or milk products, not subsequently re-infected, having caused any of these conditions. This impressive fact is alone responsible for pasteurization being applied to a high percentage of all milk sold in the larger towns and cities of the United States, to virtually all milk sold in the Province of Ontario, and to at least 70 per cent of England's milk supplies.

Milk Products

The campaigns to extend the application of pasteurization to milk supplies seem largely to have by-passed the milk products. Yet in butter, for instance, not only can *M. tuberculosis* and staphylococci survive, but Pullinger and Kemp (1) have shown *S. typhi* and a wide variety of other Salmonellas still alive in artificially infected butter which had been kept at 3°C. or at 15°C. for two or three months. Again, in cheese, *S. typhi* and staphylococci have survived long enough and in sufficient numbers to have caused several outbreaks of typhoid fever and of staphylococcal food poisoning; and Ranta and Dolman (2) have reported that *S. typhi* inoculated into Cheddar-type cheese survived therein for about one month at 23°C., and for as long as five months at 5°C. Ice cream has been repeatedly incriminated in outbreaks of typhoid and paratyphoid fever, while bacillary dysentery and staphylococcal food poisoning have also been traced to this product. Buttermilk appears to have seldom featured as a medium for pathogenic bacterial multiplication, probably owing to its high content of non-pathogenic micro-organisms, to the low pH attained, and to the beverage being favoured by comparatively few. The following account of staphylococcal food poisoning from buttermilk may therefore be of interest.

A physician and his wife drank respectively one glassful and one-half glass of buttermilk at a lunch counter at 1 p.m. Two hours later the doctor was seized with violent vomiting and diarrhoea, and shortly afterwards his wife was similarly affected. The doctor had convulsions, and prostration became so marked that a fellow-physician was called in, who at 8 p.m. found him practically pulseless, breathing with difficulty, and suffering cramps of the leg and chest muscles. A cardiac stimulant was administered hypodermically, and recovery set in. The wife endured a similar, but less severe course of events. By next day, both had recovered.

Enquiry elicited that the proprietor of the lunch counter had recently bought a cow, said to be healthy; and that the cream was gathered from the daily milkings, pooled with that yielded by the previous few days' milkings, kept warm near the kitchen stove, and churned twice weekly. The buttermilk from each churning was brought to town, and added to what remained in the receptacle in his shop. Samples of the buttermilk, and also of butter and of milk from the cow, examined at the Provincial Laboratories, all showed large numbers of haemolytic staphylococci. The buttermilk, whose pH was 4.2, gave a plate count of roughly 100,000 colonies per cc., while milk from two quarters of the cow yielded 250,000 and 300,000 colonies per cc. Two weeks later, milk from one quarter of this cow gave a count of over 1 million haemolytic staphylococci per cc. Eleven months later, the cow had freshened again and was still excreting large numbers of staphylococci, two quarters giving milk with counts

of one million and 330,000 colonies per cc. Throughout the period of observation, the strain of staphylococcus seemed to remain constant, beta-toxigenic colonies being conspicuously absent.* Filtrates prepared from the strain gave a positive kitten reaction.

Apart from its interesting epidemiological features, the above episode is remarkable in that enterotoxin should have been elaborated, or at least remained potent, in a medium having a pH as low as 4.2. Noteworthy too is the fact that according to the veterinarians who examined her, the cow showed no clinical signs of mastitis throughout the period of observation, while standard biochemical tests carried out on the milk by the Department of Dairying, University of British Columbia, also showed no evidence of an infected udder.

Pasteurization of milk to be used in cheese manufacture is a particularly urgent need. This product, because of its high food value, is being shipped overseas in huge volume; and all of the half a billion pounds or so of Cheddar-type cheese sent to Britain from Canada since the war began has been made from raw milk. The only official regulation covering its storage time is apparently that such cheese must be held eight days before boxing for export. There seems no valid reason why this type of cheese should not be manufactured in Canada, as it is in New Zealand, from pasteurized milk only. The greater safety of the resulting product would more than compensate for its mildness and slower rate of maturation. For connoisseurs whose palates seek more pungent and exotic flavours, the alternative safeguard of storage of the cheese before release for sale might be enforced. The resolution forwarded recently by the Canadian Public Health Association to the Dominion authorities, urging that Cheddar-type cheese be stored for at least three months prior to release for sale, and the decision that the contract for cheese supplied the Armed Forces in Canada should specify four months' storage of the product before distribution, are therefore alike commendable.

Sewage and Garbage Disposal

Discussion of the relationship of faulty community sanitation to bacterial food poisoning should not be closed without some reference to sewage and garbage disposal, which is so closely linked with rat and fly control. The only general comment called for here is that the proliferation of rodents (apart from the menace they present as intermediate hosts for several human pathogens) tends to increase the incidence of the Salmonella infections and of leptospirosis, while an increased fly population inevitably encourages the spread of typhoid-paratyphoid-Salmonella infections, bacillary dysentery and poliomyelitis. The following brief accounts of two outbreaks of typhoid fever illustrate the extent to which a large modern city may put up with nuisances and hazards arising in its midst or on its outskirts through very elementary faults of community sanitation.

Nearly two years ago, five sporadic cases of typhoid fever occurred among the residents of a Japanese community close to Vancouver. No contacts between cases, and no carriers,

**I am indebted to my colleague Miss Donna E. Kerr, Assistant Director of the Provincial Laboratories, Vancouver, who carried out the bacteriological examinations, and to Mr. V. Enman, Sanitary Inspector attached to the Metropolitan Health Committee of Greater Vancouver, who obtained the other data given in this account.*

could be traced; and numerous samples of raw fish, meat, milk and other foodstuffs displayed in the shops were examined at the Provincial Laboratories with negative bacteriological findings. However, the intimate confusion of uncooked foods, garbage, flies and rats which prevailed, and the open drainage ditches carrying the community sewage which bordered the streets of the little town, provided numerous alternative routes of conveyance for the infection. The isolation of *S. typhi*, type A, from the effluent of a defective septic tank serving the local hospital (which had recently housed a case of typhoid fever known to have been of type A), and the fact that all the other cases showed type A infection, eventual ly revealed the probable source of this outbreak.

A few years ago, a small outbreak of typhoid fever occurred in Vancouver, which was finally traced to crabs caught in False Creek—a salt water inlet almost traversing the city, whose euphonious name and picturesque appearance give no clue to its deplorable bacteriological content. Here crab fishermen had been permitted to let down their pots, on condition that any catch was to be boiled on board the boats. The fishermen obeyed this regulation; but the law did not forbid them to wash the boiled crabs or the utensils afterwards in the waters of False Creek; and this they apparently did. Now close to the favourite fishing spot was an outlet discharging sewage which had come in part from a large hospital. Moreover, on the banks of the inlet there were numerous shack-dwellers, whose excreta passed directly into the water; while its upper reaches received drainage from the city's open garbage dump. Nineteen cases of typhoid fever occurred, three fatal, all traced to persons who had purchased shelled crabmeat at appropriate intervals beforehand. The modest size of the epidemic gave striking support to the belief that not everyone can eat crab! From the laboratory standpoint the most interesting feature of this outbreak was that one sample of False Creek water, having a chloride content equivalent to 1.6 per cent NaCl, yielded on direct plating a large number of colonies of *S. typhi* which were found to include three phage-susceptible types. Other features of this epidemic have been previously reported by Brandon (3).

BOTULISM

Before the common types of bacterial food poisoning are considered, a short reference should be made to botulism, the rarest type, which for various reasons falls in a class of its own. The food shortages which are upon us, especially those involving meats, fruits and vegetables, are bound to lead to a great revival of home canning or bottling. The manufacturers' lack of cans, and the rationing of canned goods in the United States, will only increase this tendency. The almost inevitable result will be a higher incidence of botulism. A careful record compiled by Meyer (4) of all cases known to have occurred in the United States and Canada during the period 1899-1941 lists a total of 359 outbreaks, with 1024 cases, and 669 deaths, a case fatality rate of 65 per cent. Even if it be assumed that all cases of botulism have been reported (a most unlikely contingency) an annual average for North America of over eight outbreaks and more than fifteen fatal cases of so tragic a disease would suggest that every pamphlet issued on food preservation in the home should include clear instructions aimed at preventing elaboration of the toxins of *Cl. botulinum*.

Meyer's series includes only two Canadian outbreaks, to which the following one should probably be added.

Five Indians in the Yukon feasted on a dish locally much esteemed, namely salmon eggs, which after being tied into a moose bladder for ten days were eaten uncooked. A few days later the group was spotted drifting in a canoe down the Thirty-mile Rapids 100 miles below Whitehorse. Dr. N. A. Stewart, formerly of that city, to whom I am indebted for these details, located the party by seaplane, finding two already dead in the canoe. A third death occurred in hospital, while the remaining two recovered. Although circumstances did not permit any

laboratory work to be carried out, the nature of the food, the incubation period, the symptomatology, and the high case fatality rate, all fit the diagnosis of botulism.

A recorded total of three Canadian outbreaks is disproportionately low when compared with Meyer's total of 357 for the United States. This is not necessarily due to poorer reporting of botulism, or to better methods of preserving food, in Canada, but may result from an uneven distribution of *Cl. botulinum*. In this connection it is noteworthy that in Great Britain only two outbreaks and one or two single cases of botulism have been recorded. Of these the best known remains the 1922 Loch Maree (5) outbreak, involving eight cases, all fatal, and traced to wild-duck paste.

SALMONELLA FOOD INFECTION

Incidence

Food poisoning outbreaks are notorious for the unreliability of statistics respecting their incidence. This generalization is particularly applicable to Salmonella food poisoning, whose true incidence has been obscured not only through inherent difficulties of isolating Salmonella organisms actually present in the peccant food or in the faeces of its victims, but also through the ascription to Salmonella food poisoning of many outbreaks in which no viable organisms of this group were present. Nevertheless there is some reason to believe that Salmonella food poisoning may be relatively more prevalent in Britain than in North America. For instance, according to Hinden (6) the Ministry of Health received reports from England and Wales over the 15-year period 1923-37 of 299 outbreaks of Salmonella food poisoning, affecting 4418 persons, of whom 102 died, giving a recorded case fatality rate of 2.3 per cent. These figures give an annual average of 20 outbreaks, with 294 persons involved and roughly 7 fatalities. However, the fluctuations from year to year were considerable; for instance, in 1937 alone, 45 Salmonella outbreaks were reported, involving 601 cases and 24 deaths. There are no strictly comparable North American statistics; but Fuchs (7) reports for the United States in 1939 an exceptionally high total of 148 outbreaks of food poisoning of all kinds (including botulism and trichinosis) involving 3,782 cases, with 12 deaths. This gives a case fatality rate of only 0.3 per cent, which probably reflects a relatively low incidence of Salmonella food poisoning, as well as the recognition of some staphylococcal outbreaks.

Modes of Conveyance

The modes of conveyance of Salmonella food infection are potentially very numerous, but are rather seldom revealed, owing to the incompleteness of the epidemiological investigations conducted. Savage (8) states that the path of infection was satisfactorily proved in only 10 per cent of the 121 outbreaks reported to the Ministry of Health in England over the period 1919-31 in which Salmonella organisms were actually isolated and identified. The same author lists (*ibid.*) the chief modes of conveyance as consumption of the meat, milk or eggs of an infected animal, and pollution of food by human carriers, or by infected rats and mice. Savage appears to underestimate the

role of the human carrier, and to dismiss with undue readiness the potentialities of the fly as an agent of transmission. Moreover he could hardly have been expected to foresee the extraordinary variety of animal reservoirs for Salmonella organisms disclosed in recent years.

Human Salmonella Carriers

Use of the newer selective media available for bacteriological examination of faeces from food handlers, such as brilliant green tetrathionate broth, bismuth sulphite agar, S S agar, desoxycholate-citrate agar, and Hynes' medium, is revealing a higher incidence of Salmonella carriers than was formerly suspected. Soon after the Provincial Laboratories in Vancouver began to carry out routine stool examinations of food handlers in the Armed Forces, three carriers of *S. typhi murium* were identified in one regiment alone, none of whom gave any history of prior infection. Mention may also be relevantly made to the isolation of *S. cholerae suis* from the faeces of a man whose infection proved rapidly fatal, and also from the faeces of his wife and child, who remained symptomless. Again, in an outbreak of paratyphoid B fever reported by Jones, Gell, and Knox (9) recently from England, positive stool cultures for *S. paratyphi B* were obtained from 21 out of 34 cottagers who took their drinking water from a well from which this organism was directly isolated; yet there were only four clinically typical cases, the majority being symptomless. In other words, not only are there healthy carriers to contend with, but some types of Salmonella infection may give rise to clinical syndromes so mild as to pass unnoticed. Moreover, the convalescent carrier state may persist longer after food-borne Salmonella infection than has been generally believed. Mosher, Wheeler, Chant and Hardy (10) report an institutional outbreak of *S. typhi murium* infection, apparently conveyed by turkey or its dressing at a Thanksgiving Day dinner, and involving 238 persons, from 86 (36.1 per cent) of whom the organism was isolated. During their convalescence, regular stool cultures were carried out on 195 of the infected patients. In the fourth week following infection, 41 or 21 per cent were still excreting *S. typhi murium*, 10 or 5.1 per cent showed positive stool cultures in the seventh week, while one case continued to yield positive cultures for eighteen weeks after infection. Such findings as these clearly confer upon the laboratory a considerable responsibility in preventing transmission of Salmonella infection from man to man through the intermediacy of food.

Wartime conditions have obviously multiplied the chances of carrier-borne Salmonella food infection. The current great migrations of people to meet the demands of Mars and Moloch entail not only more group or community feeding than ever before, but also result in continually changing restaurant personnel. Chefs, kitchen helpers, waiters and waitresses, if trained at all, are now even less trained than before; while a casual attitude toward the amenities of life is apt to pervade both restaurant and home kitchen, so that first the cook, and then perforce the patrons, become less particular. This growing lack of fastidiousness, together with diminishing refrigeration facilities, rising food costs, and an actual scarcity of some foodstuffs, are bound to lead here, as in Britain, to left-overs being picked about

and heated up for later consumption: altogether a set of circumstances providing optimal conditions for food contamination by human carriers.

Animal Salmonella Reservoirs

The laboratory's interest in the control of Salmonella food infection should extend beyond the investigation of outbreaks and the identification of human carriers. There is also the possibly more important function (which should not be left to veterinary laboratories) of increasing our knowledge of the numerous animal reservoirs for those Salmonella organisms which are pathogenic for man. There are some 37 official (and many other unofficial) Salmonella typing centres throughout the world, which have gradually added to the list of known distinct types. The alphabet has long been exhausted in the search for symbols for the flagellar antigens alone of the many scores of Salmonella types now recognized. The work of these typing centres has greatly expanded our conceptions of the susceptibility of various species of wild and domestic animals to Salmonella infection. The special liability of rats and mice to such infections has long been established, but it now appears that horses, cows, sheep, pigs, goats, dogs and cats, turkeys, ducks and chickens, and many other animal species, are subject to Salmonella infections of greater or lesser severity, which manifest their presence by septicaemia, abortion, gastro-enteritis, or by some minor ailment. Salmonella carriers may also be found among animals. Moreover, it has been shown that many Salmonella types formerly thought to be exclusively animal pathogens may also be pathogenic for man. *S. dublin* infection of cows, for instance, has been proved responsible for several milk-borne outbreaks of acute gastro-enteritis. Scott (11) alludes to the isolation of types of Salmonella known to be pathogenic for man, including *S. cholerae suis, typhi murium, thompson,* and *newport,* from the mesenteric glands or spleens of about 5 per cent of apparently healthy pigs passed for slaughter in England. Bornstein and Saphra (12) report human infections due to *S. saint paul,* first isolated from turkeys, and to *S. worthington, urbana,* and *manhattan,* all hitherto regarded as fowl rather than human pathogens; while there have been several reports of food poisoning from duck eggs found to be infected with *S. typhi murium* or *enteriditis.* Again, some months ago cultures were received for identification at the Salmonella typing centre operating in the Western Division of Connaught Laboratories, which had been isolated by Prof. E. G. D. Murray at McGill University from a fatal septicaemic outbreak in dogs. The cultures proved to be *S. bredeney* which is not only pathogenic for man, but has also been isolated, according to Hinshaw, Taylor, and McNeil (13), from normal swine, and from a wide variety of birds, including the turkey, duck, quail, guinea-fowl, and chukar partridge. Finally, Olitzki (14) records the finding of *S. kentucky* (originally isolated from a chick with ulcerative enteritis) in a man and three cachectic camels with intestinal trouble.

Many additional examples of the above kind might be submitted to emphasize that some aspects of the aetiology of Salmonella food infection illustrate well those associations we are increasingly having to trace between the diseases of man and of animals. But it must suffice our present purpose

to add that in wartime there is an increased risk of Salmonella infection arising not only from human carriers, but also from those shipments of hastily inspected and indiscriminately purchased cattle and poultry which are likely to be distributed so long as meat shortages remain acute.

Clinical Manifestations

Three main clinical forms of human Salmonella infection may be differentiated, their chief characteristics being respectively: (i) acute gastro-intestinal irritation, (ii) typhoidal syndrome, (iii) blood stream infection. To some extent, as might be expected, the severity and nature of the resulting illness is governed by the type of Salmonella involved; but this generalization cannot be carried too far, and differences in virulence or toxicity among strains of the same type probably cause equally significant variations in the clinical picture. The infectivity rate among those eating the incriminated food is usually high. The incubation period is 12-36 hours, after which there is a sudden onset of vomiting, diarrhoea and abdominal pain, accompanied by fever and prostration. The abdominal pain and diarrhoea are often severe, but the illness is typically over in a few days, although sometimes of longer duration. There is an appreciable mortality rate of 1-2 per cent. In an outbreak, the causal Salmonella is often recoverable from the faeces of patients with characteristic symptoms, and may also be isolated occasionally from exposed persons who have remained symptomless, or whose only complaint may be slight diarrhoea.

Salmonella "Toxin" Hypothesis

In England the view still prevails that the form the illness takes will be largely determined by the ratio of preformed toxic metabolites to living micro-organisms ingested with the peccant food. This view is based on a hypothesis originated by Savage to account for the high proportion of food poisoning outbreaks in which no strain of Salmonella could be isolated either from the suspected food or from its victims, and in which the incubation period was short. The earliest version of this hypothesis is embodied in the following quotation from Savage (15):

> "In some cases the living infective bacilli are ingested with the food with none or but little of their toxic products. In such cases the incubation period will be of appreciable duration since time must elapse before the bacilli can manufacture sufficient toxins to manifest symptoms. In other cases the bacilli may be killed during the process of manufacture, or preparation for the table, and only the heat-resisting toxic products will be left. These being preformed will exert their poisonous properties rapidly. The majority of outbreaks must be looked upon as being caused by a mixture of bacilli and toxins, the bacilli having had time to grow in the food before it was consumed."

This conception was further developed and applied by Savage and White (16) and again by Savage (8). Its general acceptance in Britain led there to recognition not only of the "bacterial" type of Salmonella food infection whose salient features have been already described, but also of a "toxin" type, characterized by an incubation period of usually 2-4 hours only, an illness of 24-36 hours' duration, negative stool cultures, and a very low case fatality rate.

Without thought of detracting either from the plausibility of Savage's hypothesis in the light of the known facts at the time of its promulgation, or from the prestige which its sponsor earned for his authoritative work on bacterial food poisoning, it must be stated that the conception of the "toxin" type of Salmonella outbreaks no longer seems valid or helpful. From the first there were certain inherent weaknesses in its logic. For instance, there seems no satisfactory reason why Salmonella organisms should not at times have been isolated from either the suspected food or the faeces of patients in outbreaks characterized by the brief incubation period of the "toxin" type; for it has been frequently shown that some types of Salmonella can survive certain cooking procedures. Again, it seems reasonable to expect that the "bacterial" type of outbreak should often include cases featuring a 2-4 hour incubation period, owing to significant amounts of preformed toxin being taken along with the living Salmonella organisms in the food. Yet such deviations from the usual pattern are rare, and when they do occur, as in the outbreak due to *S. typhi murium* reported by Hinden (6), may be explained otherwise (as will be developed later) than in terms of preformed Salmonella toxins.

The existence of Salmonella toxins capable of early effects upon the human gastro-intestinal tract when taken by mouth, has still to be convincingly demonstrated. Numerous early workers, particularly in Germany, reported that killed suspensions and culture filtrates of certain of the organisms we now class in the Salmonella group, might exhibit heat-stable toxic effects when fed to or injected into laboratory animals. A generation later, interest was revived in this field, resulting in a considerable literature to which only a few references need be made here. Ecker (17) showed that some strains of *S. paratyphi B* could elaborate, within 24 hours in a nutrient broth medium, a thermostable substance which had toxic effects upon rabbits when given intravenously. Injection of 2 cc. of filtrate was followed 40-45 minutes later, by dyspnoea, prostration, diarrhoea and paralysis of the extremities—death or recovery ensuing within 24 hours. Branham (18) described similar effects upon rabbits and mice (but not guinea pigs) from the intravenous injection of *S. enteritidis* culture filtrates and autolysates, although no harm was observed to follow their administration by other routes. Again, Ecker and Rademaekers (19) showed that intravenous injection of filtrates of certain *S. paratyphi B* cultures grown for 15-24 hours in veal infusion broth might produce marked diarrhoea in rabbits, associated with demonstrably enhanced peristaltic movements of the small intestine; while Menten (20) described glycaemic reactions and other toxic effects in rabbits after intravenous injection (and after oral administration of as much as 25 cc.) of *S. paratyphi B* and *S. enteritidis* filtrates. A similar toxic action in rabbits was reported by Menten and King (21) following intravenous injection of *S. typhi murium* filtrates; while from the same type of Salmonella, Raistrick and Topley (22) later extracted a heat-stable polysaccharide which had toxic effects upon injection into rabbits and mice.

The antigenicity of the toxic substances described by many of the foregoing workers permits their findings to be summarized by the statement that certain heat-stable, soluble somatic antigens of the Salmonella group are

liable to be toxic for some species of laboratory animals when injected into their blood stream. The evidence that a toxic action may be exerted on such animals by oral administration of similar preparations is less convincing. Geiger, Davis and Benson (23) fed rabbits with various foodstuffs which had been incubated for 10 days at 37°C. after inoculation with one of several types of Salmonella. Despite the enormous doses of living or dead Salmonella organisms given, there were only one or two deaths among the large number of rabbits used, while diarrhoea was shown 1-4 days after the experimental feeding by only a small proportion of the animals. Dack, Harmon and Jarra (24) (whose paper includes a useful review of the earlier literature in this field) obtained no evidence of gastro-intestinal irritation after feeding relatively large amounts of 48-hour or 14-day heat-killed cultures of *S. typhi murium* to rhesus monkeys, rabbits, dogs and a cat, except that one monkey had diarrhoea on the day following ingestion of a dose of concentrated preparation equivalent to 500 cc. of the original filtrate. Verder, Downing and Wilcox (25) fed *S. typhi murium* and *S. enteritidis* to white rats. Diarrhoea occurred 24 hours or more after administration of living cultures, but there were no symptoms when heat-killed cultures were given. Again, Dack, Jordan and Wood (26) reported that monkeys gave evidence of intestinal infection on the day following ingestion of heavy doses of living *S. typhi murium* and *S. enteritidis* suspensions; but no reaction whatever was provoked by heat-killed suspensions of the same organisms. Similar results were obtained by Verder and Sutton (27) who caused gastro-enteritis to develop in monkeys 18 to 48 hours after feeding them living cultures of *S. enteritidis*, the incubation period varying according to the number of viable organisms fed; whereas no reactions followed oral administration of heat-killed cultures or filtrates.

On the other hand, Geiger and Meyer (28) reported that boiled, 3-4 day cultures of *S. typhi murium*, fed to mice in amounts of 0.5 cc. or less, caused death in 6-24 hours, the animals showing at autopsy a greatly distended duodenal loop and a hyperaemic ileum. The same authors failed to obtain significant reactions in rabbits, guinea pigs and cats, but produced symptoms of food poisoning in a monkey, under similar treatment. Branham, Robey and Day (29) gave boiled 24-hour broth cultures and culture filtrates of 17 strains of *S. typhi murium* and *S. enteritidis* intragastrically to mice, with the result that about 40 per cent of the animals died in 5 to 14 days. The 24-hour filtrates proved more lethal than those prepared from 3 and 7-day cultures, while 14-day culture filtrates caused no deaths. The strains used had all been shown to kill 100 per cent of mice, mostly in 4 to 9 days, when fed to them in live culture. Savage (30) found that mice died within 48 hours of being fed with boiled cultures or filtrates of various types of Salmonella, positive results being however dependent upon a satisfactory medium and freshly isolated strains being used. He obtained completely negative results in kitten feeding experiments of a similar nature. Finally, Jordan and Burrows (31) reported vomiting in monkeys fed 25 cc. of filtrates prepared from three strains of *S. typhi murium*, which had been either freshly isolated or recently subjected

to repeated transfer on a starch agar medium. Their findings await confirmation.

This outline of the literature bearing on the conception of a "toxin" type of Salmonella food poisoning, while far from exhaustive, is believed to represent an objective summary of the more recent animal experimental work recorded in this field. The only conclusion to be legitimately drawn from the various reports is that suitably prepared filtrates or heat-killed cultures of some strains of certain types of Salmonella may contain factors which are toxic for some species of laboratory animals. The toxic effects manifested when such preparations are injected intravenously, and those which follow oral administration, are probably due to quite different factors; and there is no evidence suggesting that either type of toxic effect is analogous to the "toxin" type of food poisoning syndrome in man. Little connection is apparent between e.g. diarrhoea in rabbits or death of mice occurring some hours or even days after oral administration of a Salmonella filtrate, and the onset in man of violent vomiting and diarrhoea within 2 to 4 hours of ingesting food containing supposedly preformed Salmonella toxin. Moreover, even if the animal effects described more nearly resembled the human syndrome in question, conclusions respecting human susceptibility are notoriously unwarranted when based on feeding experiments involving mice, rats, rabbits, kittens or even monkeys.*

Acceptance of the foregoing arguments logically entails resort to human volunteers. Only two reports can be traced of any conclusive experiments of this sort; and neither is favourable to the conception of soluble Salmonella factors which can be preformed in foodstuffs in sufficient concentration to give early and acute enterotoxic effects in man. Dack, Cary and Harmon (33) failed to induce any gastro-intestinal distress in 24 humans fed amounts ranging from 20 to 340 cc. of heat-killed cultures or filtrates of several strains of *S. typhi murium* and *S. enteritidis*—the two types of organisms most commonly involved in proven outbreaks of Salmonella food infection. Verder and Sutton (27) fed several volunteers culture filtrates or heated suspensions of custard cultures, using two strains of *S. enteritidis*, one of which had been recently isolated. One person took as much as 350 cc. of heated custard culture washings, another took 200 cc. of sterile custard culture filtrate, and two others each took 300 cc. of the latter preparation. No significant symptoms resulted in any instance. One person by mistake took a custard culture insufficiently heated to kill the organisms, and became ill with typical Salmonella food poisoning of "bacterial" type after an incubation period of 20-24 hours.

**Savage and White (32), for example, in contrasting the effects of S. paratyphi B and S. typhi murium infections in man and laboratory animals, emphasized that the former organism had never been convincingly implicated in either the "toxin" or "bacterial" type of Salmonella food poisoning outbreak, any food-borne infection due to this organism resulting rather in paratyphoid fever. Yet Savage (30) himself records fatalities in mice fed boiled cultures of S. paratyphi B and even of S. typhi; while the toxicity of filtrates and heat-killed cultures of these organisms when injected into certain laboratory animals has been repeatedly demonstrated.*

To summarize, although a far greater number of negative human feeding experiments, involving a wider variety of types of Salmonella, and using freshly isolated strains, would need to be carried out before the categorical claim could be made that a "toxin" type of Salmonella food poisoning cannot occur, the available evidence to date does not suggest that Savage's hypothesis accounts for any significant proportion of such outbreaks. Savage himself foresaw (8) that an alternative conception might eventually be found to fit the facts more satisfactorily. In a later section of this paper the belief will be propounded that staphylococcus enterotoxin may be responsible for the majority of the "toxin" type of food poisoning outbreaks.

SHIGELLA FOOD INFECTION

Food-borne bacillary dysentery requires less discussion than was given to the Salmonella food infections, partly because the Shigella group of organisms is rarely associated with animal infections, and partly because the group has not been involved in any controversy respecting the elaboration of preformed toxins in food. However, as Neter (34) has recently pointed out in a review of this genus, Shigella infections do occur spontaneously in monkeys, dogs, foals, geese, chickens and canaries; and it is at least possible that some of the types involved in these animal infections may be pathogenic for man. As for the question of toxigenicity, the Shiga bacillus of course produces a typical exotoxin, while heat-killed cultures of the Flexner bacillus may be lethal for laboratory animals. Notwithstanding these facts, food-borne Shigella infections are accepted as primarily due to contamination of the foodstuff by the hands of a carrier, or by flies. Their control therefore depends upon raising the level of community sanitation; and also upon supplementing the best that the laboratory can do towards the detection of carriers by more education and control of food handlers.

The fact that consumption of the flesh, milk or eggs of infected animals is not a recognized mode of transmission of bacillary dysentery to man, accounts for the lesser incidence of food-borne infection due to the Shigella group as compared with the Salmonella group. A similar explanation possibly underlies the delayed recognition of food-borne infections due to the Shigella group. The 1919 milk-borne Flexner dysentery epidemic in Aberdeen, reported by Kinloch (35), which involved about 1000 persons of whom 72 died, is apparently the first instance on record of a proven Shigella food poisoning outbreak.

Shigella Carriers

As pointed out by Mosher, Wheeler, Chant, and Hardy (10) the convalescent carrier state tends to be more prolonged after an attack of bacillary dysentery than after an attack of Salmonella food poisoning. Moreover, carriers may be found among persons giving no history of any intestinal trouble. In the course of the routine stool cultures performed in the Provincial Laboratories at Vancouver on Army food handlers, four healthy carriers of

Shigella dysenteriae Flexner and one of *Shigella dysenteriae Sonne* (in addition to two carriers of *S. typhi* and three of *S. typhi murium*) were found among the first 1000 individuals examined. Had it proved possible to examine more than one specimen from each person, additional carriers might well have been detected, as the following episode suggests.

A certain regimental officers' mess acquired as their cook a former chef of the ill-fated S.S. "Normandie". A specimen of faeces sent in from this man for routine examination yielded a single suspicious colony on the SS agar medium, which proved to be *Shigella dysenteriae Sonne*. When a repeat specimen sent in one week later proved negative, the temptation was great to ignore that single colony. The officers' mess enjoyed the chef's excellent cuisine for three weeks before the next specimen of faeces arrived. It proved to be loaded with *Shigella dysenteriae Sonne*. Discretion was then deemed the better part of valour, and the man discharged from the Army. Ten months later, the cook (who gave no history whatever of intestinal trouble) was found to be still excreting dysentery bacilli.

Clinical Manifestations

The symptoms exhibited in food-borne outbreaks of bacillary dysentery depend to a large extent upon the type of Shigella involved. Infection with the Shigella bacillus does not particularly concern us at present in this part of the world, while no attempt will be made to differentiate clinically between infections due to the Flexner and Sonne organisms. It seems more relevant to our purpose to emphasize that in a given outbreak, whatever the causal organism, the infection may evoke symptoms covering a wide range of severity. Even in outbreaks of e.g. Flexner dysentery showing a case fatality rate of 5 per cent or higher, careful bacteriological examinations will usually disclose some mild and missed cases.

The main features of a typical attack of food-borne bacillary dysentery are diarrhoea, abdominal pain, fever and prostration, vomiting being less characteristic. The incubation period is usually 1 to 6 days, about 48 hours being the average time elapsing between ingestion of the contaminated food and the sudden onset of diarrhoea. But if a sufficiently large dose of organisms be swallowed, the incubation period may be shorter.

For example, a laboratory technician accidentally sucked into her mouth at noon a small quantity of a suspension of *Shigella dysenteriae Flexner*. At 2 a.m., 14 hours later, she awoke with diarrhoea, abdominal pain and fever. Culture of a stool specimen collected an hour or two later showed enormous numbers of *Shigella dysenteriae Flexner*. An illness of several weeks' duration ensued.

Excluding the Shiga bacillus from consideration, it seems reasonable to presume that variations in the length of the incubation period in outbreaks of either Shigella or Salmonella food infections are fully explicable in terms of such factors as the number of organisms ingested; their capacity to multiply in the human intestinal tract, and the potency of the endotoxins therein liberated; the pH of the upper portions of the gastro-intestinal tract; the nature of the meal which included the peccant food; the various immunity mechanisms of the host; and the possible influence of external temperature upon the bactericidal power of the intestinal tract, which Arnold (36) demonstrated in puppies artificially infected with *S. enteritidis*.

BIBLIOGRAPHY

1. Pullinger, E. J., and Kemp, A. E.: J. Hyg., 1938, *38:* 587
2. Ranta, L. E., and Dolman, C. E.: Canad. Pub. Health J., 1941, *32:* 73.
3. Brandon, K. F.: Canad. Pub. Health J., 1940, *31:* 10.
4. Meyer, K. F.: Personal communication.
5. Annual Report, Chief Medical Officer, Ministry of Health, 1922, pp. 117-31.
6. Hinden, E.: Lancet, 1940, *238:* 145.
7. Fuchs, A. W.: U.S. Pub. Health Rep., 1941, *56:* 2277.
8. Savage,W. G.: J. Prev. Med., 1932, *6:* 425.
9. Jones, D . J., Gell, P. G. H., and Knox, R.: Lancet, 1942, *243:* 362.
10. Mosher, W. E., Wheeler, S. M., Chant, H. L., and Hardy, A. V.: U.S. Pub. Health Rep. 1941, *56:* 2415.
11. Scott, W. M.: Lancet, 1940, *238:* 409.
12. Bornstein, S., and Saphra, I.: J. Infect. Dis., 1942, *71:* 55.
13. Hinshaw, W. R., Taylor, T. J., and McNeil, E.: Cornell Vet., 1942, *32:* 337.
14. Olitzki, L.: J. Hyg., 1942, *42:* 547.
15. Savage, W. G.: "Food Poisoning and Food Infections", Cambridge Univ. Press, 1920, p. 47.
16. Savage, W. G., and White, P. B.: "Food Poisoning", Med. Res. Council, Spec. Rep. No. 92, 1925.
17. Ecker, E. E.: J. Infect. Dis., 1917, *21:* 541.
18. Branham, S. E.: J. Infect. Dis., 1925, *37:* 291.
19. Ecker, E. E., and Rademaekers, A.: J. Exper. Med., 1926, *43:* 785.
20. Menten, M. L.: J. Infect. Dis., 1926, *38:* 354.
21. Menten, M. L., and King, C. G.: J. Infect. Dis., 1930, *46:* 275.
22. Raistrick, H., and Topley, W. W. C.: Brit. J. Exp. Path., 1934, *15:* 113.
23. Geiger, J. C., Davis, E., and Benson, H.: Am. J. Pub. Health, 1924, *14:* 578.
24. Dack, G. M., Harmon, P. H., and Jarra, I. E.: J. Prev. Med., 1928, *2:* 461.
25. Verder, E., Downing, E., and Wilcox, H. W.: J. Infect. Dis., 1933, *33:* 245.
26. Dack, G. M., Jordan, E. O., and Wood, W. L.: J. Prev. Med., 1929, *3:* 153.
27. Verder, E., and Sutton, C.: J. Infect. Dis., 1933, *33:* 262.
28. Geiger, J. C., and Meyer, K. F.: Proc. Soc. Exper. Biol. & Med., 1928, *26:* 91.
29. Branham, S. W., Robey, L., and Day, L. A.: J. Infect. Dis., 1928, *43:* 507.
30. Savage, W. G.: J. Hyg., 1933, *33:* 233.
31. Jordan, E. O., and Burrows, W.: J. Infect. Dis., 1935, *57:* 121.
32. Savage, W. G., and White, P. B.: J. Hyg., 1925, *24:* 37.
33. Dack, G. M., Cary, W. E., and Harmon, P. H.: J. Exper. Med., 1928, *2:* 479.
34. Neter, E.: Bact. Reviews, 1942, *6:* 1.
35. Kinloch, J. P.: J. Hyg., 1922, *21:* 451.
36. Arnold, L.: J. Hyg., 1929, *29:* 82.

Sanitation in the Field

G. MURRAY FRASER, M.B.
Major, R.C.A.M.C.

THE practice of preventive medicine in the army differs from civil life in that the Army Medical Officer deals with a group of individuals in a fixed age group who, at the beginning of their military life, are pronounced in good health. With the pitfalls of infancy, adolescence and old age removed there should be little except the hazard of accidents and gunshot wounds to create problems for the health officer. However, the exigencies of army life require the close contact of individuals in barracks, and on active service enforce exposure to an environment that may at times be dangerous to health. Cerebrospinal meningitis, if it gains a foothold, flourishes like a green bay tree. Diphtheria and scarlet fever occur sporadically but might well become epidemic. Diseases usually associated with childhood such as measles, mumps, chickenpox and german measles, though creating only mild illness, are responsible for hospitalization and loss of time of not a few soldiers. In the actual field where troops live in tents, bivouacs or huts, there is the added menace of the excremental diseases due to inadequate care of the disposal of excreta. On the other hand the hygienist, being an officer, has the advantage of dealing with a group, the individuals of which are trained to give and obey orders. Measures to remove the sources and control the spread of infection can be published in orders by unit and formation commanders with the assurance of their being carried out.

This article is a discussion of some of the problems that have been met during the course of over three years' active service in the Canadian Army in England and the methods used to overcome them, with some observations regarding the general principles on which sanitation in the field is to be carried out.

Active service implies to the soldier a life in the battle zone in which there is contact, occasional or continuous, with the enemy. Gone are the comforts of barrack life, and he experiences physical discomforts due to environment. He lives in dugouts or holes in the ground or, if he is lucky, in an abandoned house in a shell-torn village. He is exposed for long hours to the weather, with little or no opportunity for a change of clothing and a rest. Baths are a rarity and a real bed is something he dreams about as part of his distant past. His food is good but monotonous and there are times when he goes short because of the tactical situation. However, the vast majority of our troops are now on duty on the home front and it has been their lot in this present war to experience a different kind of active service. True, they have left behind the comforts and orderly routine of the training area and live in different surroundings, but the zone of battle today is an altogether different place from the popular conception of 1914-1918. They may live in tents in the summer and during cold weather occupy huts or houses requisitioned by the War Department. Their food is

well prepared and cooked because the kitchens are more or less permanent. They have opportunities for regular baths and when they come in after a tour of duty they can have a change of clothes. Paradoxically, the risks of death from enemy action are no greater than those faced by the average civilian. In fact, the life of the average soldier is in many cases more comfortable than it was when he was under training in barracks and it is difficult for him to realize that he really is on active service. However, whether in training or in the field, one of the necessities of his life is that hygiene and sanitation shall continue to be practised. Environmental hazards exist wherever he finds himself and only by constant preparedness can his health be safe-guarded so that when the time comes for him to meet the enemy he will have the vitality and stamina to play his part.

SANITATION IN BARRACKS

Requisitioned buildings such as schools, stores, houses, stables, etc., are technically known as barracks. Sanitation in them is concerned principally with ventilation, the preparation and cooking of food, and the disposal of human and house wastes.

For adequate ventilation, the War Office standard requires that each man shall have at least 450 cu. ft. of air space and 45 sq. ft. of floor space. Where double bunking is used, the volume may be reduced to 325 cu. ft. Due to the unavailability of buildings it is found occasionally that men have been crowded into rooms in which the floor space and air volume per man are much less than the requirements and the standard has therefore been reduced so that, with the consent of the formation hygiene officer and provided there is no barrier to the free flow of air through the room, the floor space may be reduced to 30 sq. ft. An added difficulty is the need for blackout screens which in order to be effective must be practically airtight. Numerous attempts to design a blackout screen with ventilation have been made, their object being to permit the window to remain open and at the same time prevent the egress of light. Where overcrowding is necessary, men are required to sleep in a row alternately head to foot, so that the possibility of droplet infection is reduced.

Kitchens in use may vary in size and convenience from the spacious well-equipped suite of the large home to the petrol burner set up in a garage or back shed, but no matter what the size or the equipment, there are rules of sanitation which can be carried out by the conscientious cook and his staff. There can be little excuse for uncleanliness of personnel and their clothing and utensils. The liberal use by the former of soap and a nail brush and for the latter of cleansing powder applied with a brush and what is colloquially known as "elbow grease" is necessary for the maintenance of a high standard of sanitation. Fixtures such as drain boards, sinks, cupboards, shelves, etc., require daily scrubbing. Tables used for the preparation or serving of food can be kept clean and white only by daily scrubbing with a stiff brush, using cleansing powder and soap and hot water. Cooks and their helpers are examined by the medical officer and certified as free from communicable disease before being permitted to enter the kitchen, and any personnel who give a history of the enteric type of disease and whose services

in the kitchen are indispensable have stools examined in a recognized laboratory. Men temporarily employed as kitchen fatigue are forbidden the kitchen if they have a history of an enteric disease. The physical examination of the helper, except for an investigation into his past history, is not practicable, due to frequent changes.

In the men's mess cleanliness is of course essential. Regular and frequent wet sweeping and scrubbing of the floor and daily scouring of the tables are necessary. The washing of mess-tins has always presented a problem. Where the men are responsible for cleansing their own, facilities are provided adjacent to the mess in order that the washing may be carried out at once, thus forestalling the tendency to carry their utensils to the dormitories or tents for future attention which is too often forgotten. It has been found that the two-tub method, using a hot solution of water and soap or water and soda in the first tub followed by a clear hot rinse, is the most practicable. Where ample supplies of chlorine compounds are available, a rinse of 200 to 400 p.p.m., followed by a clear water rinse, is used. However, for reasons of economy, these supplies often are not available, except on the certificate of a Medical Officer, and then only if trench mouth exists in a unit, and the hot water method is practically universally practised. Kitchen staffs should be instructed to supply water of a sufficient temperature and volume that it will act as a thorough cleaner and will have some disinfecting value.

Perhaps the biggest problems met by troops on the home front is the disposal of sullage water and human excreta. With troops quartered in requisitioned houses the sewerage intended for an average family becomes greatly overburdened. Some houses built and intended for ten persons may be required to accommodate as many as thirty to fifty men. Where a water carriage system emptying into municipal sewers exists, there is no trouble. But a different picture is to be seen in rural districts. Here the usual method of sewage disposal is to drain it into a cesspit from which it is removed at regular intervals by contractors. A certain amount of digestion takes place as in a septic tank but not to an extent that may be advantageous. A few private plants are found in which are employed modifications of the contact bed or the trickling filter, but these are the exception rather than the rule. Cesspits are emptied regularly, filter beds are renewed as required and under ordinary circumstances in the well-regulated English household no bother is experienced and no nuisance exists. But let us assume that due to the risks or fear of enemy action the owner and his family, five in number, move out and the house is requisitioned by the War Department. Fifty soldiers move in. Wastes from baths, basins, kitchens, and toilets are increased ten-fold. The cesspool rapidly fills and overflows in a stream on to the next-door neighbour's garden. It is here that the difficulties of meeting the emergency are experienced. Due to the shortage of help and the amount of additional work thrown on the contractor, several days may elapse before the cesspit can be emptied, and before he can repeat his visit it has again filled and overflowed. Prompt action by the commanding officer is necessary to prevent a condition which is unsanitary and, to say the least, unsatisfactory. Toilets are placed out of bounds during the hours of daylight and outside urinals

and deep trench or bucket latrines provided. Baths and ablution facilities are reduced and kitchen wastes reduced to the minimum. If these precautions fail to give satisfactory results and the situation continues beyond control, more rigorous action is indicated. Inside toilets are discontinued entirely. All ordinary ablutions are stopped and the men taken for baths to the nearest mobile bath detachment. It has been found that these methods of control, though inconvenient, are effective.

SANITATION IN CAMPS

The different practices and methods that are used to solve the problems arising out of the accommodation of troops under canvas or in huts are known as Camp Sanitation.

The possibility of aerial observation and offence has made obsolete the instructions regarding the siting of the camp. It is no longer possible to arrange rows of white tents in the open according to plans found in military texts. The necessity for concealment under trees, disruptive painting of canvas, dispersal and the avoidance of making roads or tracks has entirely altered the old rules. Sanitary arrangements have also been modified to meet other problems such as the disposal of liquid and human excreta, the necessary use of ground usually considered unsuitable for camps and the shortage of materials such as lumber and metal used in constructing sanitary appliances.

Overcrowding must also be prevented in tents as in barracks. The soldier soon learns that the more men there are in a tent, the warmer it will be. The creation of a "fug" seems to be the desire of most and must be discouraged by properly spacing them and allowing the entrance of fresh air so that the atmosphere in the tent remains in a fit condition to be breathed. During the day in clear weather the walls are rolled to freshen the tent and dry the floor. The ground is cleared and blankets aired daily. Even in rainy weather the tent can be ventilated if the leeward wall only is rolled. When no beds are available and the men sleep on straw-stuffed palliasses placed on ground sheets, care must be taken that the straw is changed regularly every three or four weeks, as it tends to become broken and matted and may become infested.

In the absence of a proper structure the kitchen may be set up in a marquee or under a tarpaulin, so located that foliage acts as a natural cover. This latter expedient frequently necesitates the use of ground with poor drainage but the need for concealment is paramount. The principles of sanitation in the kitchen as learned by the cooks in barracks can be followed in a modified form even under such adverse conditions. No matter what the difficulties are, it is possible by the use of energy and ingenuity to maintain cleanliness of equipment and personnel and manage the disposal of wastes in a manner safe for the troops. Solid wastes are kept separate and saved as swill or salvage. Arrangements are made for the regular removal of swill by civilian contractors who are usually glad to get it for their stock. Empty tin containers, valuable as salvage, are also saved and removed by unit arrangements to salvage dumps.

The disposal of liquid waste is the most difficult problem in relation to the kitchen. The most suitable method is to run it into a soakage pit after passage

through a grease trap. Provided the soil is sufficiently absorptive, grease-free sullage water will gradually soak away into the bottom and sides of the pit. An excavation 4 feet by 4 feet by 4 feet is dug, filled to within six inches of the top with rubble or perforated tins, covered with sacking or branches, and finally with a layer of earth. The filling material prevents the collapse of the walls and breaks up the entering stream of liquid.

Major Clay (1), R.A.M.C., has recently demonstrated that a soakage pit 8 feet long, 2 feet wide, and 4 feet deep, while giving the same cubic volume, increases the soakage surface by 16 square feet, an obvious advantage as it is through the walls and floor that fluid is absorbed. As has been stated, the grease must be removed from sullage water before it is allowed to enter the soakage pit. The simplest appliance for its removal is the cold water grease trap. It functions on the principle that grease in suspension in hot water will coagulate and rise to the surface when cooled by contact with cold water. The size should be such that the volume of water in the trap is about six to eight times the volume of the inflow. The 50 gallon trap is the most commonly used, although in larger kitchens bigger traps are required. The shape of the trap is important. According to Clay and demonstrated effectively by several in use at present, a long, narrow, deep trap with a length-to-breadth proportion of three to one is the most satisfactory. Traps up to 150 gallon capacity can be made of wood, but any size over that should be of concrete. To retard the flow baffles are placed at intervals in the trap in such a way that the incoming water passes under the first, over the second and under the third. Baffles may be made of wood or metal and are placed in slides in such a manner that they may be easily removed for cleaning. A box with screening or a perforated tin bottom is placed over the entrance to act as a strainer for food debris. The principal causes for failure in the functioning of grease traps are faulty construction, faulty installation and inadequate or careless management. Common errors of construction exclusive of size consist of poorly installed box strainers and baffles poorly or carelessly placed. Box strainers should be deep enough to hold sufficient straining material and also prevent the inflowing liquid from splashing on to the surrounding area. The most satisfactory method of placing baffles is in vertical slides made of 1 inch by 2 inch strips nailed to the inside of the box. It must be remembered the wood swells considerably when constantly exposed to water. Baffles of wood should be 1 inch shorter than the inside width of the box and the slide should be 1 inch wider than the thickness of the baffles. This allows for the natural expansion of the wood and permits it to be easily slid in and out. The first and third baffles should be a sufficient distance from the bottom to permit the even and steady flow of the stream. Approximately 1½ inches has been found most suitable. The trap is installed by sinking it in the earth with the lid at ground level. Puddled earth is filled in around the outside and the effluent pipe placed in position. The commonest fault in installation is that the workman in his enthusiasm to ensure a good flow cuts the end of the trap and places the pipe too low. This naturally lowers the volume of water in the trap and defeats its purpose. The effluent pipe should be placed so that its lower edge is at least 1 inch above the top of the centre baffle and still below the top of the end baffles.

Coagulated grease then rises to the surface between the end baffles and over the centre. No grease trap, no matter how well built and installed, will carry on indefinitely without attention. The management of the trap, if properly carried out, will prolong its service and life. The strainer box is filled daily or if necessary twice daily with straw, hay, grass or bracken, all of which act as a sieve and strain out food debris. This material is replaced as necessary, and burned or buried. Twice a week the greasy scum is skimmed off and buried. By boiling down it is possible to salvage some useful grease from the skimmings. As a certain amount of sludge collects in the bottom of the trap, the baffles are removed and the bottom cleaned out about every two weeks. The practice of nailing down the trap cover or covering it with a layer of earth in the belief that once installed the trap will function satisfactorily is mentioned only to be condemned.

In bivouacs or temporary camps of no more than two days' duration a simple and efficient type of strainer trap may be used. The trap consists of a hole 1 foot square and 6 inches deep connected by a channel 3 feet long, 6 inches wide and 6 inches deep to a soakage pit. The trap is filled with bracken, grass or other straining material which can be removed and burned or buried. If desired, a 4 gallon petrol tin with a perforated bottom may be used as a strainer. The method used is optional, but some type of trap or strainer is necessary and no troops should be permitted simply to dig a hole into which all kitchen waste is carelessly thrown.

It occasionally happens that the earth has little or no absorptive properties and the soakage pit fills to overflowing. If the tactical situation prevents removal of the kitchen to a better area, some method must be found to dispose of the surplus water. A second soakage pit connected by a trench to the first may be dug or an attempt may be made to dispose of the liquid by evaporation. For the latter it is necessary to provide shallow beds or pans 15 to 20 feet square and 12 inches deep. The beds are arranged with connecting channels so that different groups are used alternately. As there may be some absorption, the bottom should be loosened occasionally. If desired, a herring-bone system of trenches 1 foot deep and 1 foot wide may be dug and the effluent allowed to flow into alternate sections. Loosening of the earth in the bottom of these trenches is also indicated.

The sanitary disposal of human excreta has always been and still is the most important problem in a camp. Its solution consists in the early provision of latrines and urinals and it is the duty of every soldier from the Commanding Officer to the youngest recruit to ensure that this is done and that fouling of the camp area is avoided. For temporary camps of not more than two days' duration the one-two-three shallow trench latrine is most satisfactory and suitable. A site is chosen down wind from the kitchen, yet sufficiently close to the men's lines to be convenient. Rows of trenches 1 foot wide, 2 feet deep and 3 feet long at two-foot intervals are dug in the proportion of five for the first hundred and three for each additional hundred men. The sod is carefully stripped and placed at the back with the dug earth. Care is taken to see that the side walls of the trench are at least perpendicular or preferably undercut to prevent fouling.

A shovel or scoop is provided and instructions issued that each man is to cover his own excreta. A screen is provided around the row of trenches. Common faults are the improper size of the holes, inadequate lateral distance between trenches and failure to provide a shovel or scoop. At the end of twenty-four hours or when the trenches are full, a fresh series is dug, the old ones filled in, re-sodded and marked with the letter L. When camp sites are used for more than three days a more substantial type of latrine is needed. Either the deep trench latrine, the bored hole, or the bucket type is installed. The former consists of a trench 3 feet wide, 10 feet long and 6 to 8 feet deep over which is placed a latrine superstructure suitable for five seats. To overcome the fly nuisance, the appliance is solidly built, has self-closing lids for the seats, and has a margin of oiled sacking held in place by about 6 inches of earth. This type of latrine was in almost universal use until recently although, due to the shortage of building materials such as wood and sheet metal in the early months of the war, it underwent many modifications. The usual type found in camps was a trench with a pole stretched lengthwise over it. It was a crude makeshift, and from a sanitary standard was most inadequate. A simple and material-saving method of modification had to be adopted to make it fly-proof. To do this a second pole was placed behind and above the first. From the front pole burlap sacking was stretched to the front edge of the trench and from the other to the back. The ends were filled in with smaller pieces. Strips of sacking reached from the rear pole and hung over the front, being held taut by a strip of wood along the free edge. Another type was made entirely of saplings with the back and ends banked with earth. These structures, though primitive and uncomfortable, were sanitary and met the requirements. Deep trenches in standing camps have now been replaced almost entirely by bucket latrines. This is a good type of appliance and if properly installed and serviced is the most sanitary. The commonest defect found is that the seat lids become broken or displaced. These should be examined daily and if damaged should be repaired. Arrangements are made for daily emptying and removal by a civilian contractor who should be cautioned to use care in removing the contents in order not to foul the ground. Buckets should be thoroughly cleaned and swabbed out with old oil before being replaced. They should rest on a cement base. The bored hole latrine is made by drilling with an auger a deep hole eighteen inches in diameter, and about twenty feet deep. The placing over the opening of a short length of tile or cement drain on which is a seat with a self-closing lid, completes a practical and sanitary latrine. The lack of light due to depth and small diameter discourages any flies that may gain access and, provided no shallow well is within 200 feet, there is no danger of pollution. The urinal for the temporary camp consists of a hole 2 feet wide, 6 feet long and 6 inches deep, with the earth in the bottom loosened for another 6 inches. The excavated earth is deposited along one side and both ends, so that the urinal is used from one side only. It is usually placed in the area of the shallow trench latrines and should be filled in and moved when their location is changed. In standing camps of more than three days' duration the best type is the J-shaped trough draining through a pipe to a soakaway pit. Many ingenious modifications which are quite adequate and

sanitary can be made from old petrol tins and oil drums. The trough-type urinal which empties into a bucket is unsatisfactory because it so frequently happens it is not emptied often enough and overflows, causing a nuisance. The digging of a soakage pit into which the urine drains is the most satisfactory method of correcting this defect. However, buckets may be used as night urinals and should be located liberally and conveniently throughout the camp and near enough to huts and tents to be used. It must be borne in mind that the average soldier is reluctant to move far afield at night to empty his bladder. He should be instructed in the dangers of fouling the ground, but the instruction will be of little value unless adequate sanitary facilities are generously provided and conscientiously used.

SANITARY PERSONNEL

The sanitary condition of the area occupied by a unit is the direct responsibility of the commanding officer but each officer, N.C.O., and man is responsible for the adequate care and precautions necessary for the maintenance of a high standard of sanitation.

The War Establishment of most units calls for men to be assigned to sanitary duty. Because of the nature of the work and because the average junior officer is unfamiliar with or ignorant of the importance of this particular aspect of army life, usually men of less than average intelligence are appointed as sanitary duty personnel. Too often we find the dullard who is inefficient in other military duties finally assigned to the sanitary squad. But it is a mistake to assume that the carrying out of sanitary duties is a task for the untrained soldier of less than average mental capacity. The guarding of the health of the troops is too important and vital a responsibility to be left haphazardly in the hands of such an individual. By good luck rather than good management, units with such personnel escape the penalties of neglecting the proper observance of hygiene and practice.

However, units who find themselves in tropical or semi-tropical climates have early learned the value of strict observance of sanitation discipline. In such areas an unsanitary environment can react with uncanny speed to affect the general health of troops, whereas in temperate climates sufficient warning and time are given usually to correct defects before they cause disease. Because of the importance of their duties, sanitary personnel should be appointed from the more intelligent soldiers and if not already trained should have a period of instruction under capable instructors. Trained sanitary personnel should not be used as permanent sanitary fatigue men whose only duty is the digging of latrines and urinals, but should be used as advisers in matters of sanitation and treated with the respect their knowledge deserves. Intelligent and sympathetic co-operation and encouragement of sanitary duty personnel by officers, N.C.O.'s and men will contribute considerably to a high standard of hygiene and sanitation in the unit.

In conclusion it must be emphasized that even though the Canadian Army in England is on an active-service footing the conditions of life are by no means comparable with those on the actual field of battle. The solution of the problems

of sanitation in camps and barracks as discussed above has been comparatively easy because of the lack of enemy interference. Except for a comparatively short interval early in the war, essential materials for building have been available and the construction of sanitary appliances has been carried on with ease and safety. But it will not always be so. The time will come when the main body of our troops will be in actual combat with the enemy and when, due to interference, the practice of good sanitation will be dangerous and difficult. We may feel confident, however, that when that time comes the practical training in sanitary methods gained by our troops in the long months of waiting will prove of inestimable value and will ensure that no matter what the environment may be the principles of sanitation will be observed.

REFERENCE

(1) Clay, Major H. H., R.A.M.C., J.R. San. Inst., 1942, *62:* 62.

Educational Techniques for Nutrition*

L. B. PETT, PH.D., M.D.
Director of Nutrition Services
Department of Pensions and National Health
Ottawa

A COMMITTEE planning to work in nutrition is faced with such a diversity of possible approaches to the public, and is often handicapped by such a lack of experience, that the final result is not always as satisfactory as might have been the case. Some people can think only in terms of nutrition classes or food demonstrations, some think in terms of the radio or little plays. The following is an attempt to list systematically various techniques, together with suitable comments.

It must be recognized at the start that there are two activities in nutritional education, closely related and yet distinct. Let us call these Publicity and Education. By this I am trying to suggest that the typical publicity media such as movies, radio, newspapers, posters and public speeches, are most satisfactory to stir up interest in further study, which then comes under the heading Education. It would be unfair to say that they cannot give some good information at the same time, but I believe that their value is more to stimulate people into further study. Experience of many people suggests that the amount of real knowledge used and retained from these publicity approaches is not great, in the absence of other educational techniques, and our criterion of success must be how much actual use is made of the information.

Under this heading of Publicity let us examine what can actually be done:

1. *Movies* are useful to create interest, to introduce or end courses in nutrition. Preferably they should be in sound and colour. They result possibly in the least retention of the list.

2. *Radio*—including half-minute health pointers, quiz programs, mentions of nutrition in commercials. Radio retains its greatest value in a well-planned series.

3. *Newspapers.* For general publicity a special effort should be made to see that nutrition news items are used, and that paid advertisements contain references to nutrition. Valuable information may be given through a planned series of articles.

4. *Posters* in stores, schools, lunch-rooms, etc., are very useful. They must be changed regularly for best effect, and are often not as valuable as expected.

5. *Public Speeches.* Local speakers should be canvassed from the professional groups, and occasional outside speakers secured, especially to inaugurate special phases of the local program. A series of lectures may be popular in some places.

*Presented before the Public Health Education Section at the thirty-first annual meeting of the Canadian Public Health Association, held in Toronto June 1-3, 1942, in conjunction with the twenty-eighth annual conference of the Ontario Health Officers Association.

6. *Exhibits* should be arranged in co-operation with the educational group. They should convey simple ideas about foods and food values. Technical words, and detailed tables and statistics should be avoided as much as possible. All material should be well-labelled and really contribute to the idea. It is also necessary to consider all possible misinterpretations, since these may greatly affect the nutrition program as a whole.

EDUCATION

While each of the items considered under Publicity is to some extent educational, the results are less permanent than those from other techniques.

1. *Schools.* More good can come through work in the schools than by any other single avenue of approach to the public. In general it should be obvious that nutrition might be included in all school courses. For example, in social studies, sources of nutritional foods could be considered. The local committee should arrange competitions for posters, essays and health slogans. See that these are displayed. Arrange for three-minute talks on foods to assemblies and other gatherings. Health plays can also be encouraged, and movies presented. Where facilities exist, animal-feeding experiments are a never-failing method of interesting students and their parents.

Of special value both for the immediate good to those concerned and as a means of education, would be the organization of school lunch-rooms and school cafeterias.

In this connection I wish to mention the interesting work of Miss Anna Speers in Winnipeg in studying the school program in relation to nutritional education. Miss Speers points out several practical things. For instance, most children leave school after completing Grade 6 but most health courses include nutrition in Grades 7 and 8. This emphasizes the need for all courses and all grades to have something on this subject. A good way to start interest in lunches is to score them throughout the school. Then study available facilities and how to improve them. Get the older classes to take responsibility where possible. Miss Speers points out the need to remember that boys as well as girls need to know about food values, and that they often learn eagerly. Use one school as a testing-ground or a demonstration.

2. Ranking equally with schools as a valuable method of giving sound nutritional information that is likely to be used, are nutrition courses and study groups. But nutrition classes need careful consideration. While the showy city-wide nutrition campaigns are useful from a publicity standpoint, most people now recognize that small groups are best. These small groups should be encouraged in all kinds of clubs and societies. Possibly the first step would be to get every club or society in the city, including churches and men's groups, to have at least one meeting on nutrition. From this might come a small group wanting to know more, and the ideal size for this small group is probably from 10 to 20 persons. People learn better and take more interest if the nutrition class is a small group who are used to seeing each other at some club, etc., and who meet

in some familiar building. When one such group has completed a "course" in nutrition then another might be ready to start. In this way classes can go on all year, with a minimum of trouble. This may not be spectacular, but it covers the community more thoroughly than bigger methods.

Even these small groups will not cover all the people because many do not belong to any club, or ladies' aid, or other society. Here I want to suggest the importance of welfare workers helping to organize classes among the people familiar to them. A community nutrition committee should start out with a good contact through social service groups. But do not let this suggest that only these groups need a study group or a lecture course on nutrition. The aim should be for every club and organization in the area to have one.

THE LEADER PROBLEM

Now each of these groups has to have a leader, and there just are not enough trained leaders to go around. Lots of areas, especially rural areas, have no such leader available. This leader problem is one of the most serious that any nutrition committee has to face, whether it be in a community, or in a province, or for the whole of Canada. It is all very well to say that we should have provincial nutritionists appointed, or that we should have city nutritionists. That is true, but it still does not solve the leader problem. We must face the fact frankly that if this nutrition program is to be launched we must have the voluntary help of everyone in Canada who has had training of any kind or at any time, in any phase of nutrition. And we also need the help of untrained or lay leaders, who are interested and capable.

It is necessary to say, however, that even trained people may not be very suitable group leaders for our Canadian Nutrition Program. They need refresher courses on the aspects of nutrition that are now being emphasized. All the more necessary are training courses for lay group leaders, who have never been to college or trained in a hospital.

This field of refresher courses is a direct and necessary concern of every town, provincial, or dominion nutrition committee. Here, too, can the paid nutritionists, as they appear, be of most value just now. This need must be faced squarely by all of us, and methods found for full co-operation among federal, provincial and community leaders in training or retraining group leaders.

I have mentioned schools and nutrition classes as two valuable methods of education. Along with the publicity stunts mentioned before, these can form the basis of a nutrition program. In addition there are some other methods or techniques which may be employed if they suit the local circumstances.

3. *Industry.* Through their lunch rooms, through auxiliary services, through their community houses and clubs, a nutrition committee can make a direct contribution to the all-important war-production by seeing what can be done for the local factory employees. Lunch-rooms and canteens can be helped. As a minimum, posters may be displayed. Specifically for war industries my own branch at Ottawa is doing a good deal in the factory, but local help is needed for outside the factory.

4. Public eating places provide another way of approaching many people with nutritional information. Exhibits, posters, and, especially, putting information on menus would all form part of this approach.

5. Food stores should be interested in nutrition activities by displaying posters from local school competitions, or by distributing leaflets in parcel deliveries, or by special window displays. Another valuable publicity technique is for stores to provide a corner for a consumer information booth where questions might be answered, or demonstrations put on.

6. The support of the libraries should not be neglected.

7. Professional groups, especially doctors, dentists, and nurses, might supply speakers, and also be persuaded to hold nutrition meetings in their own societies. This sets a very good example, and also helps these groups to keep abreast of current nutritional education.

8. All that has been said tends to apply more directly to a town or city, rather than to rural areas, yet nearly every point mentioned can be adapted to rural organizations. Special attention is, of course, needed to seasons, and crops, and transportation, which may make a rural nutrition program slower.

To summarize, then, any group in any area or community can take part in the nutrition program by getting together a planning committee of interested people. Suggestions for forming such a planning committee may be obtained from the Provincial Health Department, or from Nutrition Services, Ottawa. The plans of this local committee must include both publicity and educational features, and will vary according to local circumstances. Material for both publicity and education can be prepared locally, or secured from the above sources. Other sources will be suggested. The training of group leaders, and the building up of a community interest and enthusiasm are the first concern of the committee. Later the ball must be kept rolling by special techniques. The result wil be better health for all.

Detection of Tuberculosis in School Teachers in the Province of Quebec*

L. LABERGE, M.D.
Director, Division of Tuberculosis
Ministry of Health and Social Welfare
Quebec

THE Legislative Assembly of the Province of Quebec, on May 17, 1941, unanimously passed the act 5 Geo. VI, chap. 47, amending the Education Act. Section 231a thereof reads as follows:

"No person may hold an engagement in a public school unless he produces, every year:

"1. A physician's certificate stating that he suffers from no infirmity or disease which renders him unfit for teaching;

"2. A certificate from a phthisiologist attesting that a clinical and radiological pulmonary examination shows that such person is free from tubercular disease;

"Such examination must be made within two months following the engagement or appointment. In the case of re-engagement, the radiological examination shall not be required unless the commissioners exact it. If it be proved by a medical certificate that a person holding an employment in a public school is suffering from tubercular disease, the contract of engagement shall be rescinded without indemnification and such person must immediately cease to perform his duties.

"19b. No person may teach in an independent or private school unless he has complied with the provisions of section 231a."

If our province glories in being the first to pass such a law, we must admit that it needed it more than any other, as it is at present the one most affected by tuberculosis. Three main factors led the Council of Education to bring such a law before the Legislature:

Firstly: A wide campaign to educate the public, undertaken and conducted by the members of the Provincial Committee for the Control of Tuberculosis, during the years 1938, 1939 and 1940. The committee had also recommended this measure. The campaign reached the greater part of the population, including teachers and legislators, and convinced them of the necessity of such a law.

Secondly: A by-law passed by the City of Quebec, in July 1940, compelling all teachers of the School Commission to undergo a clinical and X-ray examination of the lungs before returning to their classes in September. A total of 523 teachers were thus X-rayed, and sixteen of these (3 per cent) were withdrawn from teaching because of active or chronic tuberculosis. Most of these people were still at the early stage of the disease, and were unaware that they were tuberculous.

**Presented at the thirty-first annual meeting of the Canadian Public Health Association, held in conjunction with the twenty-eighth annual conference of the Ontario Health Officers Association, held in Toronto, June 1-3, 1942.*

Thirdly: A personal experience, a report of which was published in one of our reviews on education, gave me the opportunity of establishing the danger of mass contamination of pupils by a tuberculous teacher. During the summer of 1940, a country school teacher came to my clinic to get a certificate that she was free from tuberculosis. The examination was negative with respect to tuberculosis, but I discovered a lesion of the heart, and her general state of health was very poor. I strongly advised her not to go back to teaching, but as her father happened to be the secretary of their local school commission, my advice was ignored and she was appointed to a school. A year later she was taken back to my clinic by the visiting nurse, in a serious condition. She had lost twenty-two pounds, her temperature was high, and she was coughing continually. She told me that about the end December she had started coughing and losing weight. Her family physician was consulted and declared the coughing to be due to the condition of her heart. He did not examine her lungs. Though ill, she continued to teach. As she was living in the school-house and cooking her own meals, her diet was defective. I made an X-ray examination again and found a bilateral tuberculous lesion.

In September, on the reopening of school, I thought that it might be interesting to make a tuberculin test on the pupils of her school. For comparison, I also made a test on the pupils of a neighbouring school. No cases of tuberculosis had been recorded by the visiting nurses in the families of the pupils attending these two schools. In the latter school, out of 18 pupils tested, I found only one positive reaction (6 per cent), but in the school where the aforementioned girl had been teaching, 16 out of 23 pupils showed positive reactions (70 per cent). These conclusive data were brought to the attention of the authorities of the Council of Education, in order to point out the danger of mass contamination among pupils whose teacher suffers from tuberculosis.

When the law came before the House, it was enacted that the examination would be free of charge, at least for those teaching in rural districts, where the teacher's salary is rather low. The Minister of Health offered the services of his travelling clinicians for the examinations. A heavy task was thus imposed upon these specialists for they had to make the examinations in addition to holding their regular clinics throughout the fifty-six counties organized as Health Units. Special clinics had to be held also in the seventeen other unorganized counties. By the end of November, most of the rural lay and religious teachers had undergone an examination of the lungs, both clinical and X-ray.

In view of the magnitude of the task they had to perform and the short period of time at their disposal, the clinicians could not radiograph so large a number of people. They used radioscopy on everyone, and had a chest film taken only on those who showed doubtful clinical or radioscopic signs. However, most of the teachers who had previously lived in a contaminated family were radiographed.

Thanks to this law, introduced by the Council of Education, of which all the bishops of the province are members, the doors of the teaching religious congregations were thrown wide open. This was most important, as we knew in advance that it was there that we would find the largest number of tuberculous cases.

I must, however, draw attention to the fact that, during the past few years, especially since our campaign of education, most of the religious congregations have required an X-ray examination of the lungs from those applying to be admitted into their community. In many cases a further examination is required before they take their final vows. Many applicants whose health was not adequate to the requirements of religious life were thus rejected.

Many difficulties arose in the enforcement of this new law. Those members of the teaching body whose state of health was precarious, saw therein the danger of losing their position, and would not admit the symptoms which could have guided the clinician in his diagnosis. Others, whose health certificate had been withdrawn by a clinician, would consult another physician and thus get a new certificate. We were in a position to control these cases through the tuberculosis division, where the names of all rejected persons are recorded.

As I mentioned before, nearly all the persons teaching in rural districts had been examined by November, 1941, and all the teachers in the city of Quebec had been radiographed by the same time. For Montreal, the organization was slower and more complicated, as the payment of the expenses had to be determined. Finally the cost was borne by the different school commissions at a rate of two dollars per film. All the teachers of the Catholic and Protestant School Commissions in Montreal were radiographed during the winter and spring of 1942.

From the reports sent to me, three tables have been compiled. The first table gives the results of the examinations made in the city of Quebec and the rural districts; the other tables show the results in Montreal and the surrounding towns for the respective teachers of the Catholic and Protestant School Commissions.

TABLE I

EXAMINATION OF SCHOOL TEACHERS FOR TUBERCULOSIS
ALL THE PROVINCE EXCEPT THE CITY OF MONTREAL

Teachers examined (16,524)				*Teachers diagnosed as tuberculous*		
Teachers		*Total*	*Active*	*Non-active*	*Under observation*	*Rejected*
Females	religious	6,152	59 0.95%	65 1.0%	136 2.2%	115 1.8%
	lay	7,401	34 0.46%	23 0.31%	135 1.8%	63 0.85%
Males	religious	2,155	14 0.69%	13 0.61%	39 1.8%	27 1.2%
	lay	816	5 0.61%	5 061.%	13 1.6%	7 0.86%

This table shows that out of a total of 16,524 teachers examined, 212, or 1.2 per cent, were rejected on account of tuberculosis of the lungs, and 112 were active cases. It also records a much higher rate of tuberculosis among the religious teachers than among the lay teachers.

TABLE II

EXAMINATION OF SCHOOL TEACHERS FOR TUBERCULOSIS
CITY OF MONTREAL
CATHOLIC SCHOOL COMMISSION

Teachers examined (4,695)			*Teachers diagnosed as tuberculous*			
Teachers		*Total*	*Active*	*Non-active*	*Under observation*	*Rejected*
Female	religious	1,879	3	....	50	3
	lay	906	6	....	27	6
Male	religious	762	....	....	27	....
	lay	1,148	6	....	41	6

These results were furnished to me by the Medical Adviser of the Montreal Catholic School Commission and show that out of a total of 4,695 teachers examined, only 15, or 0.32 per cent, were rejected for active tuberculosis. There was no mention of non-active cases. I admit that the report was not complete in regard to the religious teachers. As many religious institutions have their own medical organization, it was very difficult to control all the results. But as the examinations were made by conscientious and competent physicians, we have no doubt that all the tuberculous teachers have been withdrawn from teaching.

TABLE III

EXAMINATION OF SCHOOL TEACHERS FOR TUBERCULOSIS
CITY OF MONTREAL
PROTESTANT SCHOOL COMMISSION

Teachers radiographed at the Royal Edward	1,533
Evidence of healed primary infection	227
Primary infection in way of healing	2
Presence of pulmonary tuberculosis, minimal cases, mostly without activity. Activity to be determined by a clinical examination	70
Evidence of pleurisy without implication of the parenchyma and lymph nodes	36
Cases under observation	16
Non-tuberculous	1,182
Teachers rejected	1
Per cent of cases with radiological signs of primary infection or re-infection	23%

Table III shows an analysis of the radiological signs found in 1,533 chest films taken from the Protestant School Commission's teachers in Montreal, Westmount, Verdun and Outremont. Only one teacher was rejected on account of active tuberculosis.

Statistics for the school year 1938-39 indicate that out a total of 29,245 professors and teachers in the province of Quebec, about 24,000 are under the jurisdiction of the Public Instruction Council. As will be seen from Table IV, 22,637 of these were examined with the help of our travelling clinics, our dispensaries and our school commissions organization. The rest were examined through private organizations and their control was practically impossible.

TABLE IV

TOTAL RESULTS OF THE EXAMINATION OF SCHOOL TEACHERS FOR TUBERCULOSIS PROVINCE OF QUEBEC, 1941-42

Total of teachers examined and controlled	*Tuberculosis*			*Other infections*	*Teachers eliminated*
	Active	*Non-active*	*Under observation*		
22,637	128 0.56%	176 0.77%	484 2.1%	12 0.5%	228 1.0%

This last table shows that 304 teachers were found with active or non-active pulmonary lesions and that 228 were withdrawn from teaching. For the 484 teachers under observation, a new examination was recommended within three or six months.

On account of the considerable work set upon the tuberculosis organizations and the rather high expenses imposed upon a few school commissions, it is practically impossible to have all the teachers of the province examined every year. Last summer, the secretaries of all the school commissions were notified that the following must have a clinical and radiological examination of their lungs and must obtain a medical certificate:

1. Those who will teach school for the first time.
2. Those who may have taught before, but were not examined.
3. Those who received a temporary certificate, the examining physician having placed them under observation.
4. Teachers who were absent many days through sickness, during the previous year, and for whom the secretary of the school commission would require a new certificate.
5. Teachers whose state of health is doubtful and against which complaints have been made by responsible persons.

These instructions will be prevalent until further orders.

Every year, therefore, all new teachers will have to submit to a clinical and radiological chest examination and we will assume a definite control over the older members of the teaching staff who could develop tuberculosis during the school year.

Shiga Toxoid

LEONE FARRELL, M.A., PH.D., F.C.I.C.
With the technical assistance of
HELEN FERGUSON
Connaught Laboratories, University of Toronto

DYSENTERY caused by the Shiga bacillus is not a major public health problem on this continent, although outbreaks have been reported (Middleton, 1936; Block and Ferguson, 1940; Caudill *et al.*, 1942). Its chief interest for us at the moment lies in the fact that if concentrations of non-immune troops take place in areas where Shiga dysentery is endemic, considerable morbidity and mortality may result, as occurred in Salonika in 1916 (Graham, 1918). When the present war broke out, it seemed reasonable to suppose that hostilities would spread to such areas (Africa and the Middle and Far East) and work was therefore begun with the hope of preparing a suitable prophylactic.

References to attempts to prepare a formol toxoid have appeared (Dumas, Ramon and Bilal, 1926; Halapine and Basilevskaia, 1937; O'Brien, 1940; Trevan, 1940; Haas, 1940; Kesterman and Vogt, 1941) but either evidence of antigenicity is lacking, or the preparations appear to have been too toxic for general use.

The present report describes a method of preparing and formalinizing a toxic extract of *Shigella dysenteriae* (Shiga) to yield a product which was non-toxic to laboratory animals; which evoked a high titre of specific antitoxin in rabbits; which protected mice against toxin and against suspensions in mucin of living culture fatal to unprotected mice in less than 48 hours; and which has been injected into both normal human subjects and recovered patients without undue reaction but with production of significant amounts of specific antitoxin.

METHODS

Culture

The strain of *Shigella dysenteriae* (Shiga) used in the preparation of toxoid was "Bucharest Smooth."* The culture was kept at room temperature with weekly transfer on plain egg slopes. Under the conditions described below, this strain produced toxin with a minimum lethal dose (m.l.d.) for mice (intravenously) of 0.001-0.002 cc. and a combining value with International Standard antidysentery serum of 0.01-0.02 cc. Suspensions in mucin of 5-10 million microbes proved to be one average lethal dose (a.l.d.), the mice dying in less than 2 days. A minimum lethal dose was approximately twice this number.

Medium

Minced beef was digested with pancreatic extract, the phosphates precipitated with calcium chloride (0.25 per cent) and the resulting broth sterilized by Seitz-filtration. The broth was adjusted to pH 8.7, heated to 65° C., and added to freshly-autoclaved agar (9 per cent) to give a concentration of 3 per cent agar. The mixture was filled into Roux bottles, steamed for one hour and autoclaved at 15 lbs. for 15 minutes.

**Obtained through the courtesy of Dr. J. W. Trevan, Wellcome Physiological Research Laboratories, Beckenham, Kent, England.*

Toxin Production

Culture from 24-hour growth on 50 Roux bottles was washed off with 300 cc. saline into centrifuge tubes and toluene added to give 1 per cent concentration by volume (Parish and MacSween, 1940). The stoppered tubes were incubated at 37° C. for 5 days with frequent shaking, then centrifuged for 2 hours. The supernatant was sterilized by Seitz-filtration and yielded a faintly opalescent, highly toxic fluid with a nitrogen content of approximately 3.5 mg./cc., 80-90 per cent of which was dialyzable.

Toxicity Testing

White mice of a single strain and weighing 15-18 g. were used. Injections into mice were given intravenously in 0.5 cc. total volume. Rabbits weighed 1.5-2.5 kg. The time of observation for mice and rabbits was one week. In potency tests of toxin in mice, dilutions of 1:500 and 1:250 usually gave 50 per cent and 100 per cent mortality. The criterion of complete detoxification was the survival of all animals in a group of at least 4, when 0.5 cc. was given to mice and 5 cc. to rabbits, intravenously. More recently, a second dose of 5 cc. in the rabbits 7 days after the first has been required, as experience has shown that this is a more rigorous test of detoxification.

Antitoxin Titration

Because many sera contained only small amounts of antitoxin, the method of titration outlined by the League of Nations Committee (1929) could not be applied. Experiment showed that for any particular toxin a dose could be determined which, combined with 0.10 s.u. and 0.15 s.u. of antitoxin, gave 2/3 deaths and 2/3 survivals respectively in groups of 6 mice with considerable regularity. Dilutions of the unknown serum were therefore combined with this dose of toxin for injection into mice and the antitoxin level determined by comparison with control groups receiving the standard serum-toxin mixture.

EXPERIMENTAL

Detoxification Tests

Early experiments showed that simple addition of formalin, even at a concentration of 0.5 per cent, was not likely to yield a non-toxic product. Such material incubated at 37° C. for 30 days killed 4 of 4 mice when 0.05 cc. was injected. Indeed, as events showed, incubation for 18 months at 37° C. and at room temperature for an additional 4 months failed to detoxify completely. Work being carried on concurrently in the preparation of antigens for the hyperimmunization of horses confirmed the observations of Parish and MacSween (Trevan, 1940) that samples incubated near or at pH 8 were less toxic than more acid ones. The effect of pH was therefore considered. A preliminary test with 0.5 per cent formalin and adjustment of the reaction over a range pH 6.7—pH 8.2 with determination of residual toxicity after incubation for 3, 7 and 21 days confirmed the earlier observations. Although no samples became completely detoxified in 21 days, toxicity was reduced to 1/50 at pH 8.2, but only to 1/7 at pH 6.7. The work was therefore extended to include more alkaline solutions and higher concentrations of formalin.

Formalin was added to aliquots of toxin to give 0.5, 0.75 and 1 per cent concentration, and the mixtures allowed to stand 4 hours. Each aliquot was divided for adjustment of reaction to pH 8.2, 8.5, 9.0 and 9.9 with sodium car-

bonate, saline added as required to make the volumes equivalent, and all the samples were incubated for 2 weeks. For toxicity tests, the reaction was adjusted to pH 7.5 and the required adjustments in volume made with saline. The final concentration of each preparation was ¼ that of the original toxin. Groups of 4 mice were injected with 0.5 cc. intravenously.

Only the three samples incubated at pH 9.9 and the 3 containing 1 per cent formalin and incubated at pH 8.2, 8.5 and 9.0 were non-toxic for mice. These 6 samples were therefore tested for antigenicity according to a method developed with a partially detoxified preparation which was known to be antigenic for horses.

Antigenicity for Mice of Non-toxic Extracts

Three injections of 0.3 cc. of the 6 non-toxic materials described above were given subcutaneously at weekly intervals to groups of 13 mice weighing 14 g. Each mouse was weighed weekly and the regular gain in weight compared with uninjected controls indicated that all the antigens were without adverse effect. One week after the last dose of antigen the mice in each of the 6 groups were tested by the intravenous injection of toxin. Table I gives the results of this test.

TABLE I

RESISTANCE TO TOXIN OF MICE IMMUNIZED WITH DETOXIFIED EXTRACTS OF *S. Dysenteriae* (SHIGA)

Percentage formalin	0.5	0.75	1.0	1.0	1.0	1.0
Initial pH	9.9	9.9	9.9	9.0	8.5	8.2
m.l.d. of toxin	Mice surviving 7 days/mice injected					
5	1/4	0/4	0/5	...	...	4/4
10	1/5	0/5	0/4	4/4	4/4	5/5
25	...	...	...	3/4	4/4	2/4
50	0/4	0/4	0/4	2/4	4/4	...

As table I shows, no significant protection was afforded by the 3 extracts detoxified at pH 9.9. The other 3 preparations gave good protection, especially the one incubated at pH 8.5. It appears, therefore, that a rather high concentration of formalin and careful adjustment of reaction are required to prepare a non-toxic, potent antigen.

One other point should be mentioned, although it is not apparent from the table. A few minutes after the challenging dose of toxin was given to these mice, a number developed symptoms of anaphylactic shock and 8 in various groups died in less than 1 hour. Later experiments with toxin prepared on horse meat medium indicated that the sensitivity was developed to the bacterial protein and not to constituents of the broth. Glenny (Parish, 1941) observed that death of mice from anaphylaxis sometimes occurred with diphtheria toxoid given intravenously. As the latter has been proved safe for human use, the observation with dysentery antigens should occasion no concern. Shock may be avoided by dividing the intravenous dose, and this was done in the above experiment in the groups which received antigens

detoxified at pH 8.5 and pH 9.0, but this method of testing antigenicity is clearly unsuitable for routine use.

It was of interest to know what might have been the quantity of antitoxin present in the mice referred to above, in relation to a given challenging dose of toxin. Antitoxic serum of known potency was given subcutaneously to groups of mice. Twenty hours later, a challenging dose of toxin was given to groups of 4 of these animals. The results obtained in 3 experiments are condensed in table II.

TABLE II

PASSIVE PROTECTION OF MICE AGAINST TOXIN OF *S. Dysenteriae* (SHIGA)

Toxin intravenously (m.l.d.)	*Antitoxin (s.u.) injected subcutaneously 18 hours before toxin*			
	1.8	3	15	45
2	3/4*	8/8	4/4	4/4
6	3/4	4/4	4/4	4/4
10	....	2/8	8/8	4/4
50	....	0/8	4/8	8/8
150	....	....	0/4	1/4

*Mice surviving 7 days/mice injected.

The results given in table II suggest that on the whole an endpoint at 50 per cent mortality could be set at about 0.2-0.4 s.u. of antitoxin for each m.l.d. of toxin. Thus, allowing for variation, it might be presumed that when 50 per cent of a group survived 10 m.l.d. of toxin, the individuals had had a total of about 3 s.u. of antitoxin. Again, if 50 per cent of a group survived 50 m.l.d. of toxin, presumably each mouse was protected by about 15 s.u. of antitoxin. By analogy with staphylococcus antitoxin (Farrell and Kitching, 1940), these totals would correspond to levels of circulating antitoxin of about 1 s.u./cc. and 5 s.u./cc. of serum respectively. These results suggest that the mice immunized with the preparations detoxified at pH 8.5 and pH 9.0 had antitoxin in the order of 5 s.u./cc. of serum and those immunized with the preparation detoxified at pH 8.2 about half that amount.

Following the lead given by these experiments, 6 lots of toxin were incubated with 1 per cent formalin at reactions of pH 8.4 to pH 8.8 for 9 to 21 days. All were non-toxic to mice when 0.5 cc. was injected intravenously. Experiment had shown that, weight for weight, rabbits were more sensitive to Shiga toxin than were mice. After dialysis of these preparations and addition of sodium chloride to restore isotonicity, groups of 4 rabbits were given 5 cc. intravenously and observed for 1 week. All the rabbits in the groups which received 4 of the 6 preparations (pH 8.4, 8.5, 8.6, 8.8) survived. With a preparation incubated at pH 8.5 for 16 days, 1 rabbit died and on re-test 2 died. With a preparation incubated at pH 8.4 for 16 days, all 4 rabbits died. Of the 4 apparently non-toxic preparations, 3 were used in the more rigorous test of a second intravenous dose of 5 cc. one week after the first dose. Of the rabbits which received the

second dose of material incubated for 16 days at pH 8.4, 1 died in 6-7 days. When this material was re-tested on 4 new rabbits, 3 failed to survive the first injection. Experience suggests that these irregularities should be attributed to variation in susceptibility of rabbits rather than to a partial dissociation of the formol toxoid. All the rabbits in the groups which received preparations incubated for 16 days at pH 8.6 and pH 8.8 survived the second injection with little or no loss of weight. While too few lots have been made to permit definite conclusions to be drawn, it would appear that the reaction should be adjusted at least to pH 8.6 for detoxification, although some variation should be anticipated and provided for by repeated tests in rabbits as well as mice.

Antigenicity Tests in Rabbits

The 3 preparations (A, B and C) which were non-toxic by these criteria were tested for antigenicity in rabbits. The method of testing was worked out by injecting groups of 4 rabbits subcutaneously with different doses of various dilutions (1/2 to 1/12) of antigen at weekly intervals and bleeding each week for titration of circulating antitoxin. The individual animals varied widely in response to the antigens, but on the whole variation was less marked with the diluted material. A "secondary stimulus" given after a rest period of 4 weeks always evoked an excellent response, the titre increasing about fivefold to tenfold. The method finally adopted was as follows. The toxoid was diluted with saline to 1/12 the concentration of the original toxin, injected into 4 rabbits in 3 weekly subcutaneous doses of 1 cc., 2 cc., and 3 cc., and the rabbits bled for antitoxin titration 1 week after the third dose. After an interval of 4 weeks, the animals were bled, given a fourth dose of 1 cc. of diluted toxoid and a week later bled again. With preparations B and C, the dilution for the "secondary stimulus" was made from a fresh dialysate of the alkaline material which had been stored in the cold for 2 months. The results obtained with these 3 preparations are given in table III.

As may be seen in table III, all the rabbits developed significant amounts of antitoxin after receiving 3 doses of antigen derived from a total of 0.5 cc. of toxin. After the fourth dose, high levels were attained. The differences in the secondary response in the 3 groups are not statistically significant and so there is no reason to suppose that storage of the undialyzed toxoids B and C in the cold for 2 months had caused appreciable deterioration.

Protection of Mice with Toxoid against Living Culture in Mucin

Failing an opportunity to study the relation of titre of antitoxin to immunity in human subjects, a few preliminary tests were done using living culture in mice. Groups of animals received toxoid in three weekly subcutaneous doses totalling 0.5 cc., and a week after the third dose they were given, intraperitoneally, living culture suspended in 0.5 cc. of 5 per cent mucin. The suspension of culture was prepared from the overnight growth on agar slopes, the number of microbes being determined by plate counts from broth dilutions. Groups of control mice received the same dose of culture or dilutions thereof. As the point at issue in these tests is protection against invasion by the microbes and not protection

TABLE III

RESPONSE IN ANTITOXIN OF RABBITS RECEIVING DILUTED SHIGA TOXOID SUBCUTANEOUSLY

Toxoid Diluted to 1/12th concentration of original toxin	*Rabbit Number*	*Antitoxin titre (s.u./cc.) 1 week after*	
		Primary stimulus 1+2+3 cc. at weekly intervals	*Secondary stimulus 1 cc. 4 weeks after 3rd dose*
A	1	4	65
	2	4	22
	3	2	35
B	4	6	20
	5	10	18
	6	3	25
	7	3	15
C	8	2.5	+
	9	1.5	22
	10	2	30
	11	15	50

+Accidentally killed.

against "exotoxin" presumably formed *in vivo*, only the period up to 48 hours from the time of injection of living culture should be considered, although observation was continued for 1 week. The results obtained in these tests are condensed in table IV.

TABLE IV

SURVIVAL OF NORMAL MICE AND OF MICE INJECTED WITH SHIGA TOXOID AFTER INJECTION OF LIVING CULTURE SUSPENDED IN MUCIN

Dose of culture (millions)	*Mice surviving 48 hours Mice injected*	
	Normal	*Immune*
0.45	5/5	....
4.5	3/5	....
8	2/5	15/15
9	2/5†	....
14	1/5	....
20	0/5	10/13
28	0/5	5/19†
45	0/5	....

†One additional mouse died 4-5 days after injection of living culture.

As may be seen in table IV, the a.l.d. for mice was 5-10 million microbes. Against this dose the immunized mice were completely protected. A dose of 20 million was at least 1 m.l.d. and 10 of 13 animals which had received toxoid survived. When a dose of 28 million was given, the protection by the toxoid was insignificant, only 4 of 19 mice surviving through the 7 days of observation.

Although the number of animals used in these tests was small, the regularity of death amongst the controls suggests that some reliance may be placed upon survival in protected groups. Obviously, however, further study is required to determine the degree of assurance with which conclusions can be drawn.

Tests on Human Subjects

In the tests on human subjects reported here, no attempt was made to determine optimum dosage or interval, the primary object being to see whether the antigen was likely to prove safe and effective for human use. Before being filled into vials for injection, the toxoids were diluted with saline to ½ the concentration of the original toxin, and the volumes mentioned in the human tests refer to the diluted toxoid. After 2 normal subjects had had an intradermal injection of 0.1 cc. and subcutaneous doses up to 0.5 cc. with only moderate local reaction, the inoculation of other volunteers was begun. Thirteen normal persons and 7 patients who had recovered from dysentery, believed to have been caused by the Shiga bacillus, have received injections.

(*a*) *Normal Subjects*

The three lots of toxoid (A, B and C) described above were used in these tests on 13 normal subjects. The injections varied from 0.1 cc. intradermally to 0.5 cc. subcutaneously. In 4 of 5 instances in which 0.1 cc. was given intradermally, a subcutaneous injection of 0.15 cc. or 0.25 cc. was given 1 or 2 days afterwards. These 2 injections have been considered together as a single "dose". In 2 instances, the second dose was given in 2 subcutaneous injections of 0.25 cc. and 0.5 cc. 2 days apart. The doses were given at monthly intervals. Of the 13 subjects, 9 received 3 doses, with a total of 0.6-0.75 cc., and 2 received 2 courses of 3 doses, with an interval of 5 months between the 2 courses, and a total volume of antigen of 2.2 cc.

The local reaction to the first dose of toxoid varied with the individual from "slight" to "marked". Axillary tenderness was reported by 6 subjects, while a systemic reaction characterized by moderately severe chills and headache lasting about 4 hours occurred in 1. This same subject, together with 1 who had had practically no symptoms after the first dose, had a moderate, general reaction of the same type to the second. Perhaps a more disturbing feature of these tests was that 6 subjects had some recurrence of local swelling and tenderness 3 to 4 days after the injection, that is, after the first inflammation had subsided. This recurring local reaction subsided in 1-2 days without abscess formation. Evidently, however, a larger group would be required to establish that abscess formation as reported by Kestermann and Vogt (1941) would not occur. On the whole, reactions to the second dose of antigen were less pronounced than to the first, although 3 persons reported more. All agreed that the third dose occasioned least reaction.

Eight of these subjects were comparable in receiving 3 doses of 0.25 cc. subcutaneously at intervals of 1 month while one other received 0.1 cc. intradermally as a first dose and 0.25 cc. for the 2 subsequent doses. The response in antitoxin to these injections is shown in table V.

TABLE V

RESPONSE IN ANTITOXIN OF NORMAL SUBJECTS TO 3 DOSES OF 0.25 CC.* OF SHIGA TOXOID AT MONTHLY INTERVALS

Subject	*Toxoid*	*Antitoxin in s.u./cc.*		
		10 days after 2 doses	*1 month after 2 doses*	*1 week after 3 doses*
M.Y.	C	10	5	10
M.M.	C	8	5	8
E.T.	A	4	4	10
H.M.	C	4	4	7
F.F.	A	1.3	0.8	1
G.W.	B	1.0	0.5	0.7
A.B.	C	0.4	0.3	0.4
R.P.	B	<0.5	<0.3	0.4
H.F.*	B	<0.5	0.2	2.5

*Subject H.F. received only 0.1 cc. in the first dose.

Table V shows that 10 days after the second dose 7 of 9 subjects had developed a measurable amount of antitoxin, although the range in titre was very wide (0.4-10 s.u./cc.). A month after the second dose the titre was somewhat lower in most instances but in only one subject had it decreased to half of the level at 10 days. The third dose caused a measurable response in all subjects although the titre of 3 sera was below a unit. In this limited series, no relation could be observed between lot of toxoid and degree of reaction or level of antitoxin.

In the two subjects which received 2 courses of 3 doses, the first course gave a titre of 1.5-2 s.u./cc. Five months after the third dose, the titre was still about 2 s.u./cc. and the fourth dose (0.25 cc.) increased it to 6.5 s.u./cc and 7.5 s.u./cc. respectively. The fifth and sixth doses caused no appreciable change in level.

(*b*) *Recovered Patients*

Between June and September of 1940, an epidemic of dysentery caused by *Shigella dysenteriae* (Shiga) occurred in Kentucky (Caudill *et al.*, 1942). We are much indebted to Dr. Ralph Wheeler and Dr. F. W. Caudill for their part in an experiment to test the effect of an injection of toxoid upon recovered patients. About one year after recovery, blood was drawn from 6 persons believed on epidemiological grounds to have had Shiga dysentery, although they were not laboratory-proved cases. A dose (0.5 cc.) of toxoid was given to each and 10 days later blood was again drawn for titration of antitoxin. A seventh case had had severe dysentery (not laboratory-diagnosed) in the Far East 10 years before an exposure, known to be intimate, to the culture isolated in the Kentucky outbreak. Blood was drawn before and 10 days after an intradermal

injection of 0.1 cc. of toxoid in this individual. The results of these tests are presented in table VI.

TABLE VI

TITRE OF ANTITOXIN IN RECOVERED PATIENTS (NOT LABORATORY-PROVED CASES) BEFORE AND 10 DAYS AFTER 1 INJECTION OF SHIGA TOXOID

Subject	*Antitoxin (s.u./cc.)*	
	Before toxoid	*After toxoid*
R.W.*	5	15
F.C.	14	35
D.B.	13	50
C.B.	3	65
F.B.	2.8	10
L.B.	1.3	20
J.W.	<0.5	<0.3

*Subject R.W. received 0.1 cc. intradermally. The rest received 0.5 cc. subcutaneously.

As may be seen in table VI, 6 of the 7 persons had significant amounts of antitoxin before toxoid was given, even though at least a year had elapsed since recovery. Insufficient serum prevented lower testing of the seventh sample. Except in one individual (D. B.) the reactions to the relatively large dose of toxoid were trivial, being chiefly local and never severe. Subject D.B. had moderate chills and dizziness and severe headache. In the 6 persons with measurable amounts of antitoxin before toxoid, the titre was increased threefold to twentyfold 10 days after. No antitoxin was detected in the seventh sample at the lowest level tested. None of these persons had been laboratory-proved cases, but this experiment provides evidence that the first 6 had had former experience of antigens of *Shigella dysenteriae* (Shiga).

SUMMARY

1. Toxin with an m.l.d. for mice intravenously of 0.001-0.002 cc. was prepared by autolysis of a "smooth" culture of *Shigella dysenteriae* (Shiga).

2. Incubation of the toxin at a reaction of pH 8.5-pH 8.8 with 1 per cent formalin yielded materials which were non-toxic for mice and rabbits, in doses given intravenously of 0.5 cc. and 5 cc. respectively.

3. Mice which were injected subcutaneously with a total of 0.5 cc. of detoxified material ("toxoid") in 3 equal spaced doses resisted up to 50 m.l.d. of toxin intravenously. Mice which had received subcutaneously 15 s.u. of anti-dysentery serum resisted, about 20 hours later, an intravenous dose of 50 m.l.d. of toxin.

4. Rabbits which received 3 doses of toxoid derived from a total of 0.5 cc. of toxin, developed 1.5-15 s.u. of antitoxin per cc. of serum. A "secondary

stimulus" of about 0.085 cc. given 1 month after the third dose, increased the titre of antitoxin to 15-65 s.u./cc.

5. Normal mice and mice which had received 0.5 cc. of toxoid in 3 equal doses at weekly intervals were injected with living culture, of the "smooth" strain used for production of toxin, suspended in mucin. An average lethal dose for normal mice proved to be 5-10 million micro-organisms, and the animals died in less than 48 hours with considerable regularity. Against this dose, the mice which had received toxoid were completely protected. A dose of 20 million micro-organisms was at least 1 minimum lethal dose for normal mice. Of 13 mice which had received toxoid, 10 survived this dose. Against a dose of 28 million, only 4 of 19 animals were protected by the toxoid.

6. Normal human subjects (13) received 1 to 9 injections of 0.1 to 0.5 cc. of toxoid without undue reaction. Two doses of 0.25 cc. evoked the production of antitoxin to a level of 0.4 s.u./cc.-10 s.u./cc. in 7 of 8 subjects. After a third dose of 0.25 cc. all 8 subjects had a measurable amount of antitoxin.

7. Of 7 subjects presumed on epidemiological grounds to have had Shiga dysentery, 6 had measurable amounts of specific antitoxin (1.3-14 s.u./cc.) at least 1 year after recovery. Ten days after an injection of toxoid, these 6 subjects had a markedly increased titre of antitoxin (10-65 s.u./cc.). The seventh subject still had no detectable antitoxin (< 0.3 s.u./cc.).

I wish to express my thanks to Dr. R. W. Wheeler, Vanderbilt University, Nashville, Tenn., and Dr. F. W. Caudill, State Department of Health of Kentucky, Louisville, Kentucky, for generously giving of their time and energy in testing the recovered patients; to the recovered patients and my colleagues in these Laboratories who permitted tests of the comparatively untried antigen upon them, especially Dr. Donald T. Fraser, who has also made many other contributions to the problem; and to the National Research Council for a grant-in-aid.

REFERENCES

Block, N. B., and Ferguson, W.: Am. J. Pub. Health, 1940, *30:* 43.
Caudill, F. W., Teague, R. E., and Duncan, J. T.: J.A.M.A., 1942, *119:* 1402.
Dumas, J., Ramon, G., and Bilal, S.: Ann. Inst. Pasteur, 1926, *40:* 134.
Farrell, L. N., and Kitching, J. S.: J. Path. & Bact., 1940, *50:* 439.
Graham, D.: Lancet, 1918, 1, 51.
Haas, R.: Ztschr. f. Immunitatsforsch. u. exp. Therap., 1940, *89:* 121.
Halapine, K., and Basilevskaia, L.: Ann. Inst. Pasteur, 1937, *58:* 341.
Kestermann, E., and Vogt, K. E.: Klin. Wchnschr., 1941, *20:* 739 (Abst. Bull. War Med., 1942, *2:* 401.
Middleton, F. C.: Canad. Pub. Health J., 1936, *27:* 615.
O'Brien, R. C.: Tr. Roy. Soc. Trop. Med. & Hyg., 1940, *33:* 573.
Parish, H. J.: Personal Communication, 1940-41.
Trevan, J. W.: Personal Communication, 1940-41.

EDITORIAL SECTION

EDITORIAL BOARD

R. D. Defries, M.D., D.P.H., Editor
N. E. McKinnon, M.B., and J. T. Phair, M.B., D.P.H., Associate Editors
R. L. Randall, Assistant Editor

Gordon Bates, M.D. A. E. Berry, M.A.Sc., C.E., Ph.D. J. Craigie, M.B., Ch.B., Ph.D., D.P.H. J. G. Cunningham, B.A., M.B., D.P.H. C. E. Dolman, M.B., B.S., Ph.D., D.P.H., M.R.C.P. Grant Fleming, M.C., M.D., D.P.H. D. T. Fraser, M.C., B.A., M.B., D.P.H., F.R.S.C. Ronald Hare, M.D. Edna L. Moore, Reg.N. E. W. McHenry, M.A., Ph.D. G. D. Porter, M.B. A. H. Sellers, B.A., M.D., D.P.H. A. Marguerite Swan, M.D., D.P.H. F. O. Wishart, M.A., M.D., D.P.H. J. Wyllie, M.A., M.D., Ch.B., B.Sc., D.P.H.

THE HALIFAX HEALTH SURVEY

THE City of Halifax has been accused of exhibiting more in the way of concern for its traditional background than a serious interest in the health of its residents. Whether this accusation is justified or not, it became obvious early in the present war that the community health program was not sufficiently adequate to meet the demands that resulted from its establishment as Canada's most significant naval base and embarkation centre. The outbreaks of communicable illness which presumably were introduced into the community in the train of the thousands of transients who swarmed its docks and streets and swamped its already inadequate living accommodation, spread rapidly among an unprotected resident population. The steps taken by the local authorities were inadequate and early in the fall of 1941 an arrangement was entered into with the International Health Division of the Rockefeller Foundation whereby that organization undertook a survey of the public health services of the city. The report of the study, which has just been presented, has provoked much in the way of comment, most of it critical of the existing conditions. It is of interest to note that this is not the first survey in recent years that has been made of health conditions in this city. Previous efforts to arouse the public conscience were made in 1934 by the local Medical Society, and again in 1938 a study was carried out under the auspices of the Bureau of Municipal Research.

Reviewing the survey's findings we find, first, a city of approximately 70,000 people (resident population according to 1941 census) with an inadequate public health personnel, served by a variety of uncoordinated official and semi-official agencies, guided in the matter of policy-making by a committee of the elected council, whose approach to matters of public health could best be described as ultra-conservative. While many of the factors which led to the setting up of the survey were precipitated by the war and its concomitants, it is obvious that for years an attitude of laissez-faire had motivated the municipal authorities. Lack of vision and sustained leadership seem to have shared with inadequate spending in precipitating the conditions which called for reform.

Statistical evidence reveals that the general death rate* is substantially higher than one would expect in a dominantly Anglo-Saxon community; a relatively low maternal mortality rate; a high infant death rate; and a mortality from tuberculosis that should warrant grave concern on the part of those responsible for the protection of the health of the public. However, the high incidence of major communicable disease in '40, '41 and '42, particularly scarlet fever, diphtheria and meningococcal meningitis, was of more concern to the people as a whole than the less evident manifestation of ineptitude by the municipal authorities.

One can only infer from the reported findings that the resident population must share in the responsibility for the epidemics of diphtheria which occurred in the years under review. Neither was there public demand nor popular support for immunization against this disease. The outbreaks of scarlet fever and meningitis were also undoubtedly abetted by the obvious dearth of health consciousness on the part of the local residents. It is, however, in the matter of tuberculosis control that one fully appreciates the lack of public awareness in matters of personal and community health. A municipal death rate of over 100 per 100,000 of population betokens an inadequate case-finding program, or an insufficiency of sanatoria beds, or an unenlightened public, or a combination of all; the findings of the survey party lead one to deduce the latter.

In the matter of sanitary supervision, conditions in Halifax appear to lack much that is to be desired. Its regulations are outdated, their enforcement hampered by the same public attitude of mind that makes other health efforts difficult; there is an insufficiency of staff and a sustained influx of transients who add materially to already inadequate living accommodation.

In conclusion, health conditions in Halifax as revealed by the recently completed survey have provoked much unfavourable comment. In part this is due to the fact that this city has "dated itself" in the eyes of more fortunate communities by the continued annual presence of hundreds of cases of diphtheria in the civilian population; in part due to the fact that it is the chief naval port in Eastern Canada. Health matters in Halifax are no longer a matter of mere municipal concern, but are of interest to the whole of Canada. But Halifax has a well-qualified, alert health officer, a Provincial Health Department ably led and anxious to further extend assistance; an unbiased, well-prepared statement of local conditions and a municipal council presumably desirous of meeting its obligations, in view of which an accepted end result can at worst be postponed by the present shortage of well-trained personnel capable of implementing the recommendations of the survey group. Let us hope that this postponement is not resorted to, however, until every effort is made to secure the staff required.

**The death rate, however, is uncorrected for residence, and as the Victoria General Hospital is a Provincial hospital, it admits a large number of patients from all parts of the province. The rate also is calculated on census figures.*

PUBLIC HEALTH ADMINISTRATION

Appointment of Sedley A. Cudmore as Chief of the Dominion Bureau of Statistics

IN 1920 a start was made on the the establishing of a uniform system of vital statistics and the creation of national vital statistics for Canada. Year by year the Departments of Health have realized the importance of the Dominion Bureau of Statistics, through its Division of Vital Statistics, to the furthering of public health. Under the direction of Dr. Robert H. Coats, as Chief of the Bureau, a national registration area embracing the whole of Canada was accomplished in 1925. Important improvements in registration were effected and Canada's place in vital statistics was recognized in the revision of the International List of Causes of Death at the conference held in Paris in 1938.

Public health leaders learned with great regret of Dr. Coats' retirement as Chief of the Bureau, but satisfaction was expressed when it was learned that Sedley Anthony Cudmore, Dr. Coats' senior associate, had been appointed to succeed him. Dr. Cudmore joined Dr. Coats in 1919 and had been intimately associated with him in the development of the Bureau. Primarily a statistical authority on trade and co-related matters, he served as chief economic advisor at the Imperial Conference in 1926 and at the Ottawa Conference of 1932. In 1935 he was loaned to the Government of Palestine to organize a statistical department. He was born in Ireland in 1878 and came to Canada as a boy. He graduated with honours from the University of Toronto in 1905, and as a Rhodes Scholar engaged in studies at Wadham College, Oxford, for three years. Subsequently he joined the staff of the University of Toronto in political economy, later becoming assistant professor. He is a member of the Royal Economic Society, the Royal Statistical Society, and the International Institute of Statistics, of which he is one of the three Canadian members.

Approval of Establishing Cape Breton County Health Unit

FOLLOWING a survey by the International Health Division of the Rockefeller Foundation, the Cape Breton County Joint Board approved of the recommendations for establishing a full-time county health unit. It will be recalled that through the support of the Rockefeller Foundation, Dr. C. J. W. Beckwith, Divisional Medical Health Officer for Cape Breton, laid the foundations for full-time health services. The project is the result of a survey of the city of Sydney and the county of Cape Breton.

Approval of the Principle of Health Insurance by the Canadian Medical Association

AT a special conference of the General Council of the Canadian Medical Association, held in Ottawa on January 18th and 19th, the principle of health insurance was approved unanimously by the seventy-three delegates representing every province. The following resolution was adopted:

"Whereas the objects of the Canadian Medical Association are:

1. The promotion of health and the prevention of disease;

2. The improvement of health services;

3. The performance of such other lawful things as are incidental or conducive to the welfare of the public;

"Whereas the Canadian Medical Association is keenly conscious of the desirability of providing adequate health services to all the people of Canada;

"Whereas the Canadian Medical Association has for many years been studying plans for the securing of such health services;

"Therefore be it resolved that:

1. The Canadian Medical Association approves the adoption of the principle of health insurance;

2. The Canadian Medical Association favours a plan of health insurance

which will secure the development and provision of the highest standards of health services, preventive and curative, if such plan be fair both to the insured and to all those rendering the services.

Appointment of a Consultant in Nutrition, Provincial Board of Health of British Columbia

MISS MARY BALDWIN, B.Sc. (H. Econ.), was recently appointed as Consultant in Nutrition by the Provincial Board of Health of British Columbia. She will serve as liaison officer between the Provincial Nutrition Committee and the Provincial Board of Health, correlating the educational work and the general public health program carried on throughout the province by health officers and public health nurses.

"A Study on Maternal, Infant and Neo-natal Mortality"

THE Division of Child and Maternal Hygiene (Department of Pensions and National Health, Ottawa) has on hand a limited number of copies of a 64-page study prepared for distribution last summer by the Division in collaboration with the Vital Statistics Branch of the Bureau of Statistics.

This study contains 22 graphs or charts showing the variations in the rates for the various causes of deaths from 1926 to 1940 for infant and maternal mortality, and neo-natal mortality rates from 1931 to 1940 for the first day of life, and for the first, second, third and fourth weeks.

Various tables are given at the close of the study including a very useful composite table giving numbers and rates of live births, stillbirths, marriages, and infant, neo-natal, puerperal and total deaths since 1926. The text shown opposite each of the charts was prepared by Dr. Ernest Couture, Chief of the Division.

JOURNAL readers may obtain one or more copies of this study by writing to the Division at Ottawa.

Physicians Serving in the Armed Forces

THE Department of National Defence has reported that at the close of 1942 there were 2,690 physicians serving with the Armed Forces. Of this number, 1,813 are serving in the Army, 699 overseas; 614 are serving in the Air Force, 84 of whom are overseas; and 263 are serving in the Navy, 39 of whom are overseas. It is stated that during the next twelve months at least 720 additional physicians will be required. Of this number two-thirds will be physicians who have just completed their hospital interneship.

Appointments

DR. J. J. HEAGERTY, as chairman of the Advisory Committee on Health Insurance, has presented proposals for a plan of national contributory health insurance and other matters related thereto, to a Parliamentary Committee appointed to consider proposals for social security. For the present, Dr. Heagerty has been relieved of his duties as Director of Public Health Services in the Department of Pensions and National Health in order that he may serve the Parliamentary Committee. Dr. Chester P. Brown is acting as Director of Public Health Services and at the same time as Chief of the Division of Quarantine, Immigration Medical Service, and Treatment of Sick Mariners. Dr. Brown is being assisted by Dr. M. F. McGavin.

Among those serving in the Armed Forces overseas who were included in the New Year's honours list was Lt.-Col. M. H. Brown, who received the O.B.E.

DR. DONALD H. WILLIAMS, formerly Director of the Division of Venereal Disease Prevention in the Provincial Board of Health of British Columbia, is now Venereal Disease Officer for the Canadian Army.

SIR JOHN C. G. LEDINGHAM, F.R.S., is retiring from the post of Director of the Lister Institute of Preventive Medicine, London (England) and is being succeeded by Dr. A. N. Drury, F.R.S., Huddersfield Lecturer in Special Pathology, University of Cambridge, and a member of the scientific staff of the Medical Research Council.

CURRENT HEALTH LITERATURE

The Natural History of Rheumatic Cardiac Disease: A Statistical Study.

I. Onset and Duration of Disease.

THIS is perhaps the most complete study of rheumatic fever ever made. It extended over a period of 15 years and was concerned with "the natural history of this disease, as exhibited by the continued histories of given individuals, from its onset to its end in these same individuals." The records of some 12,000 patients prepared by the New York Cardiac Clinics formed the basis of the study. Of this number, 3,129 have died and this report deals primarily with this group. The white race formed 95 per cent of the total.

The incidence was equal in the two sexes, contrary to the general belief that girls are more often afflicted than are boys. The disease begins most frequently at about 8 years of age, with 15 as a mean age of onset. The initial manifestations of the disease vary with the age of onset; in youth the onset is characterized by polyarthritis in about 50 per cent and by chorea or carditis in about one-third; in adult life polyarthritis is the chief manifestation and with advancing age valvular lesions alone. The mean duration of life after the onset of the disease is about 13 years, with 50 per cent dying within 9 years. A fourth of the patients live more than 17 years and 10 per cent for 30 or more years. Expectancy is directly related to age at onset, the result being more favourable with increasing age.

Alfred E. Cohn and Claire Lingg, J.A.M.A., 1943, 121:1.

The Natural History of Rheumatic Cardiac Disease: A Statistical Study.

II. Manifestations of Rheumatic Activity: Recurrence, Severity of infection, and Prognosis.

RECURRENT manifestations of an active inflammatory process occurred in 75 per cent of the 3,129 rheumatic fever patients followed in this study. The largest number of recurrences took place between the ages of 5 and 14 years. The onset of puberty appears to mark a diminishing susceptibility to rheumatic infective processes. Carditis was the most frequent but rarely the only type of infection, polyarthritis being the most common single manifestation, especially after adolescence.

Severity of infection was related to age of onset, the proportion of severe cases decreasing as the age at onset increased. Severe infection in the early years of the disease gave a shorter expectancy than when the disease was mild. Mild infection in childhood gave a less favourable prognosis than in older persons. The type of onset also influenced the duration of life. When carditis was the first manifestation, the disease during childhood was usually severe.

Alfred E. Cohn and Claire Lingg, J.A.M.A., 1943, 121:113.

Treatment of Bacillary Dysentery in the Middle East

THIS is an encouraging account of the efficacy of the sulfonamides in the treatment of bacillary dysentery. Comparable groups of cases of Flexner infection were used to study various therapies. With the traditional saline treatment the average stay in bed was 12.6 days; cases treated with sulfaguanidine averaged 5.36 days in bed and with sulfapyridine 4.6 days. In the small series treated with kaolin (2 supplemented with pyridine later) the average stay in bed was 6.1 days. It was obvious that sulfonamide therapy for this type of dysentery was superior to other methods and that sulfapyridine was somewhat more effective than sulfaguanidine.

In an outbreak of Shiga dysentery these two drugs were again compared. The average stay in bed of cases treated with sulfapyridine was 5.7 days as against 8.01 days for cases receiving sulfaguanidine.

J. W. Paulley, Lancet, 1942, Nov. 21, p. 592.

Weight-Lifting by Women in Industry

THE entry into war industries of large numbers of women who are comparatively unused to the regular lifting of heavy loads has drawn attention to the need for protecting them from injury caused by such occupation. Although during the last war, women in British war industries successfully handled weights in excess of 50 pounds, it was recognized that such a practice entailed considerable risk. Since that time a number of studies have been made to determine the harmful effects of lifting excessive weights, the optimum load for the average woman, and the most satisfactory methods of lifting and carrying.

The pernicious effects resulting from the continual lifting of heavy loads by women are particularly evident at childbirth. For this reason there is today considerable legislation regulating the employment of women before and after childbirth.

Several estimates of the optimum load have been made. Important among them are those of the British Industrial Health Research Board after a study made in 1927. Their conclusions were as follows: (1) The optimum load is 35 per cent of the body weight. (2) In general, loads should not exceed 40 per cent of the body weight for continuous lifting and 50 per cent for intermittent lifting. (3) Persons under 16 years of age should not be permitted to carry more than 25-30 pounds; those over 16 years, not more than 40 pounds.

In 1937 the British Home Office made recommendations. In the same year the Factories Act was passed, which authorized the Secretary of State to prescribe maximum weights for various types of workers and forbid the employment of young persons in weight-lifting jobs likely to cause them injury. Various Orders are in effect, applicable to individual trades.

In the United States, the Women's Bureau, which endorsed the optimum of 35 per cent of body weight as recommended by the Industrial Health Research Board, favors State legislation empowering the factory inspection authorities to set load limits for each industry. A few of the States have legislation with respect to weight-lifting. In addition many companies enforce rules themselves.

Although none of the Provincial factory acts in Canada deal specifically with the problem, most of them have sections prohibiting any employment that would endanger health or safety.

Studies have also been conducted by such organizations as the Industrial Health Research Board, and the Women's Bureau of the United States to determine the method of weight-lifting which is most efficient physiologically. It is generally agreed that the best methods are those which interfere least with balance or centre of gravity, normal gait, posture, breathing, and circulation. Frequent rest pauses for heavy work are recommended and also pre-employment physical examinations for women entering heavy industries.

It is also suggested that employers may minimize these dangers to women workers by instructing them in the most efficient ways, by organizing the work to eliminate much lifting and carrying, and by providing mechanical devices.

The Labour Gazette, July, 1942, p. 808.

The Typhoid Carrier State Treated with Sulfaguanidine

WHILE this report has to do with the results in only 2 carriers, it was submitted because of the conflicting reports appearing in the literature concerning the value of sulfaguanidine in the typhoid carrier state.

The first individual was a healthy carrier. Specimens of faeces on 4 consecutive days were found to contain *S. typhi* while 1 blood culture, 5 urine and 3 bile specimens were negative. Sulfaguanidine was then administered, 2 Gm. q.i.d. for 6 days. Faeces specimens were negative until 7 days after the drug was stopped when typhoid bacilli were again isolated. A second

course of treatment was then undertaken, sulfaguanidine being given 4 Gm. 5 times daily for 6 days. Since cessation of treatment, 14 faeces samples over a period of 43 days were negative for *S. typhi.* The blood level of the drug during treatment was 2.48 mg. per 100 cubic centimeters. Undesirable effects of therapy were absent.

The second individual was regarded as a convalescent carrier. Bile and urine specimens were negative but 5 faeces samples were all positive for typhoid bacilli before treatment was commenced. Sulfaguanidine was administered as for case 1 and again without undesirable reactions. Seven faeces samples over a period of 17 days after cessation of treatment were negative for *S. typhi.*

Robert J. Hoagland, J.A.M.A., 1942, 120:1211.

The Efficacy of Vaccination Against Smallpox

PROOF of the efficacy of vaccination against smallpox is put in concrete form in this article and the contentions of anti-vaccinists to the contrary are effectively disposed of. Convincing statistical analysis is submitted in support of each point made by the author. In general, these points relate to smallpox incidence and mortality before and after the introduction of vaccination; change in the age incidence of smallpox due to vaccination; the absence of smallpox in vaccinated children and its occurrence in unvaccinated children in specific outbreaks; the great reduction in mortality from the disease when it does occur in those previously vaccinated compared with the rate in the unvaccinated; the successful stamping out of epidemics by wholesale vaccination (Windsor epidemic, 1924, cited); the virtual absence of smallpox in the personnel of fever hospitals.

Factual material of this kind should be in the hands of all in the public health field. The introduction of virulent smallpox into France and Great Britain in 1942 emphasizes the increased danger during war-time and the need for special efforts to maintain adequate protection by vaccination.

Sir Leonard Rogers, Med. Officer, 1942, Nov. 28, p. 173 and Dec. 5, p. 181.

The Method of Nasopharyngeal Culture in the Diagnosis of Whooping Cough

IN this study the laboratory diagnosis of whooping cough by the nasopharyngeal culture method and the cough plate method was compared. Of 438 nasopharnygeal cultures from 248 cases of pertussis 52 per cent were positive as against 37 per cent for 198 cough plate cultures from 157 cases. When primary cultures only were considered, the balance in favour of the nasopharyngeal method was even greater and the same was true when simultaneous cultures were compared. In the age group under 3, when the nasopharyngeal culture method should prove particularly useful due to the frequent absence of a satisfactory cough, 57 per cent were positive by swabbing and only 25 per cent by cough plate culture.

The method of preparing suitable swabs and obtaining the sample, and the laboratory technique are described. Some preliminary work indicates that the swab method may be suitable for field work if the charged swab is kept moist by suspending it in 0.85 per cent solution of sodium chloride in a suitable tube and the medium inoculated within 24 hours. In view of the increasing number of mild and atypical cases of pertussis resulting from the use of vaccine, such a field method is highly desirable.

Anne Morris Brooks and others, J.A.M.A., 1942, 120:883.